# MACHINERY

JANUARY 17, 1958 ONE SHILLING & THREEPENCE

## CHARGE SHEET

*wasting time by grinding cutters inefficiently*

**The best of machine tools give only mediocre results when cutters are poorly sharpened. Have you considered the advantages of the**

# CINCINNATI


## N°2 CUTTER GRINDER

**for efficient grinding of facemills, slab-mills, end-mills, form-milling cutters, gear hobs, reamers, taps, die-sinking cutters, lathe tools ?**

Work height is fixed . . . the table rolls on balls between hardened ways . . . the grinding wheel spindle runs on anti-friction bearings contained in a cartridge . . . table ways and spindle unit replaceable at small expense . . . duplicate controls offer choice of four operating positions . . . a full range of attachments available for internal and external cylindrical, surface, and corner radius grinding.

**Maintain production and profit with cutting tools correctly sharpened on a CINCINNATI No. 2 CUTTER GRINDER**

| | |
|---|---|
| Swing over table | 14" dia.* |
| Length between tailstocks | 30" |
| Face mills on workhead | 18" dia.† |
| Longitudinal table movement | 16" |

* *Using raising blocks*

† *Using face mill grinding attachment*

**Write for Catalogue now to Charles Churchill and Co. Ltd.,— London, Birmingham, Manchester, Gateshead, Glasgow.**

**CINCINNATI MILLING MACHINES LTD.**

**BIRMINGHAM 24**

# *You can now cut* ***all*** *automotive* spiral bevel and hypoid gears* ***on one machine***

You can rough and finish both gears and pinions on either the new No. 108 or No. 118 Hypoid Generator and four cutting methods are available to meet your production requirements.

**Cutting prototypes and small lots**

To cut small numbers of gears and pinions accurately and economically, you can use the *Unitool Method*. A single cutter roughs and finishes both members and covers a wide range of work with simple calculations.

**For full production—three methods.**

**Cyclex Method:**

Non-generated ring gears are both roughed and finished from the solid blank in one Cyclex operation. This is the fastest method available for producing good quality spiral bevel and hypoid gears.

**Single Cycle Method:**

Non-generated gears are first roughed out; then on the *same* machine one cutting revolution of the Single-Cycle cutter finishes each tooth. This method assures even distribution of cutter chip load and exact repetition of tooth shape with the finest surface finish. This method is four to five times faster than finishing by generation.

**Standard Generating Method:**

In separate roughing and finishing operations you can rough out and complete spiral bevel and hypoid gears. In using this method both the gear and pinion are generated and a wide range of work can be accommodated.

Such versatility alone can reduce the unit cost of your gear and pinion production. Add to this the low initial investment of the machines themselves and you've found new economy in gear manufacturing.

Spiral bevel and hypoid gears up to 8½in. in diameter and up to 4 D.P. are accommodated on the No. 108 and up to 15in. diameter and 2 D.P. on the No. 118 Hypoid Generator.

GLEASON WORKS

Builders of Bevel Gear Machinery for over ninety years.

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* Other bevel gears with ratios of 2½ to 1 or higher, such as used in tractors, earth moving equipment, etc., can be cut by these same methods.

*FULL DETAILS FROM MACHINE TOOL DEPT.*

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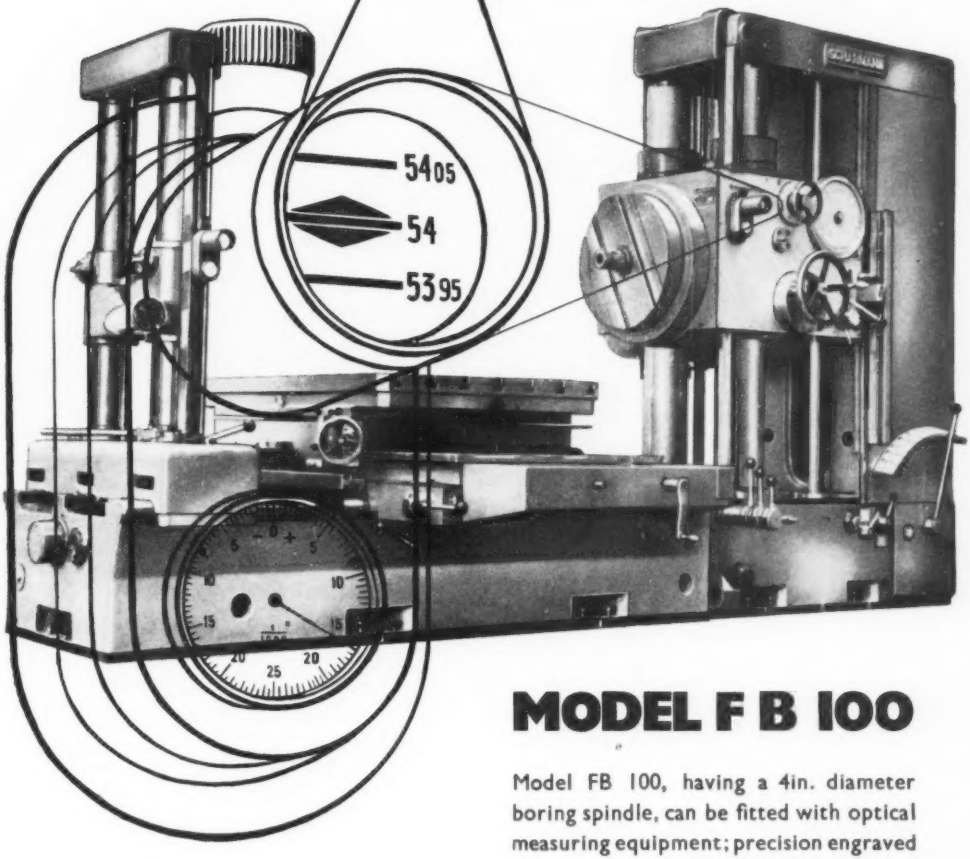
## PRECISION BORING AND MILLING MACHINE

**FITTED WITH OPTICAL MEASURING DEVICE**




## MODEL F B 100

Model FB 100, having a 4in. diameter boring spindle, can be fitted with optical measuring equipment; precision engraved glass scales enable direct positional readings to be made to the accuracy of 0·0004in. or less.

CHARLES **CHURCHILL** & CO LIMITED

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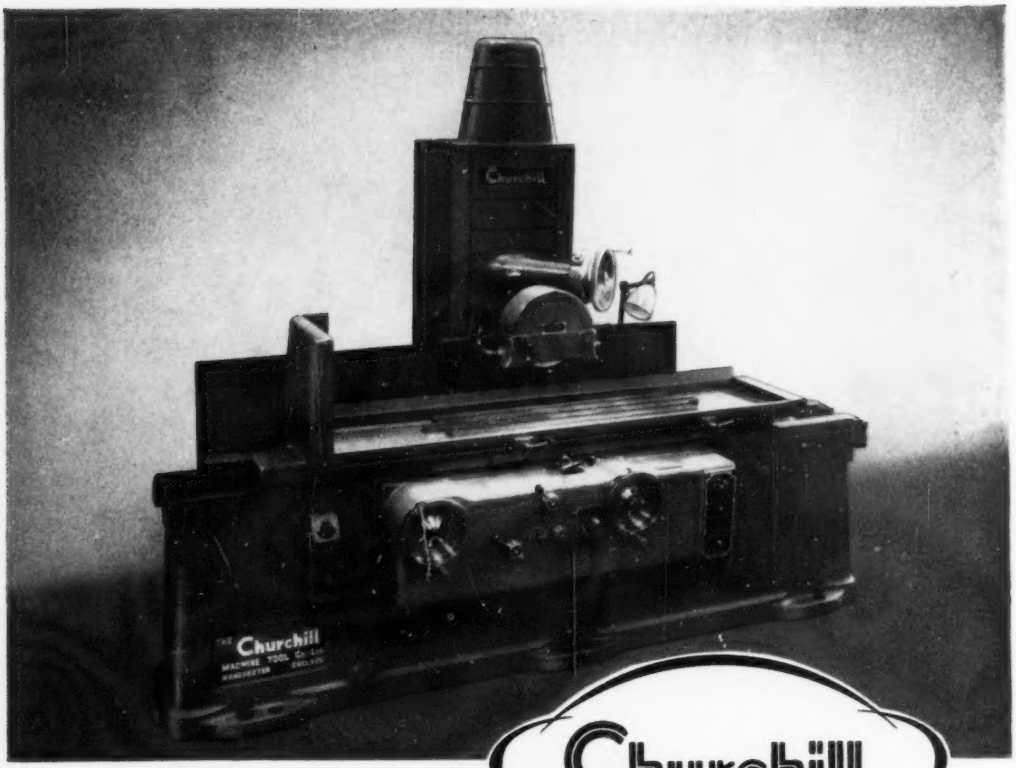


Churchill

# 'OSB'

## HORIZONTAL SPINDLE SURFACE GRINDING MACHINE

This machine is designed for work requiring extremely accurate and highly finished flat surfaces. Besides being ideal for toolroom work and for die grinding, the Model 'OSB' can be used to advantage in the production line. High rates of output are obtainable. Built in three sizes with work tables 30in. by 10in., 42in. by 10in. and 60in. by 10in.

Easy and simple operation.
Built-in motor drive to grinding wheel spindle. Motorised automatic pump lubricating system and simple bearing assembly give a high precision spindle capable of heavy grinding cuts.
Variable hydraulic cross feed to wheel. Pre-set automatic cut-out and automatic reverse.
Fine and coarse vertical feed.
Massive cross slide underneath wheelhead column gives large area of support and maximum stability.
Hydraulic table traverse up to 90 feet per minute. Hand traverse interlocked with hydraulic control.
Permanently protected precision ground table slideways. Table traverse ways, wheelhead cross slideway and cross feed gears and bearings automatically lubricated from oil supply independent of hydraulic system.

**THE CHURCHILL MACHINE TOOL CO. LTD. BROADHEATH, NR. MANCHESTER.**

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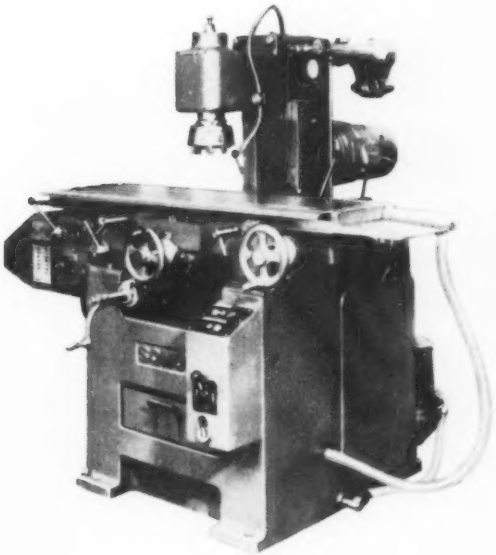
**PRECISION *plus* PRODUCTION**

C 662

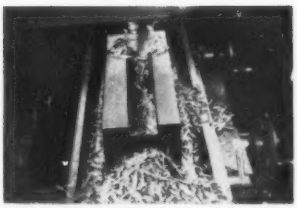
# SOMUA

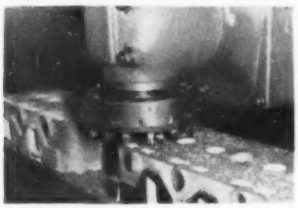
## "Z"

## MILLING MACHINES

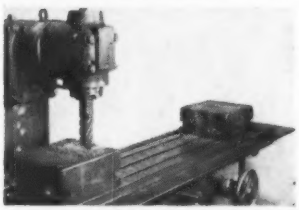


**Model 'Z1'** Milling 45-ton Steel. 2in. dia. end mill. 1¼in. per min. feed. 1in. depth of cut.





**Model 'Z3'** Rough milling diesel engine cylinder heads.



**Model 'Z3'** Machining with automatic square cycling control.

**Model 'Z3'** Climb milling.

## 900 "Z" MILLING MACHINES INSTALLED SINCE THEIR INTRODUCTION 3 YEARS AGO

| | TABLE SIZE | TRAVEL | | |
|---|---|---|---|---|
| | | Long | Transverse | Vertical |
| Z1 | 47¼in. by 11¾in. | 28in. | 9½in. | 15¾in. |
| Z3 | 63in. by 14¾in. | 39in. | 12¾in. | 17¾in. |

*Sole agents*

MTS

**MACHINE TOOL SALES (LONDON) LIMITED**

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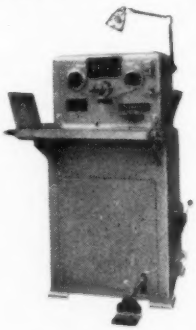
# When honing is called for...

## ring Cheltenham 56341

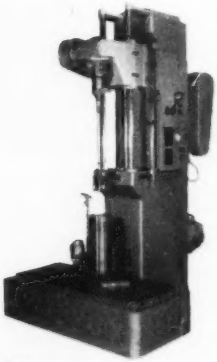
## for advice on the equipment you need

Automatic correction of taper, ovality and errors of surface finish, elimination of loss on scrap components and consistent accuracy of finish—these are only a few of the advantages that Delapena equipment offers. Give us a ring and we'll tell you anything you want to know, and give you the benefit of some sound advice on honing applied to YOUR particular needs. It will pay you to ask us about honing—we are the experts!



Horizontal Honing Machines for bores from ·120" to ·3125" internal diameter and up to 12" in length.

Vertical Honing Machines for bores from ·375" to 10" internal diameter and up tn 38" in length.



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***precision honing machines & equipment***

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*Manufacturers of Induction Heating Precision Honing Equipment*

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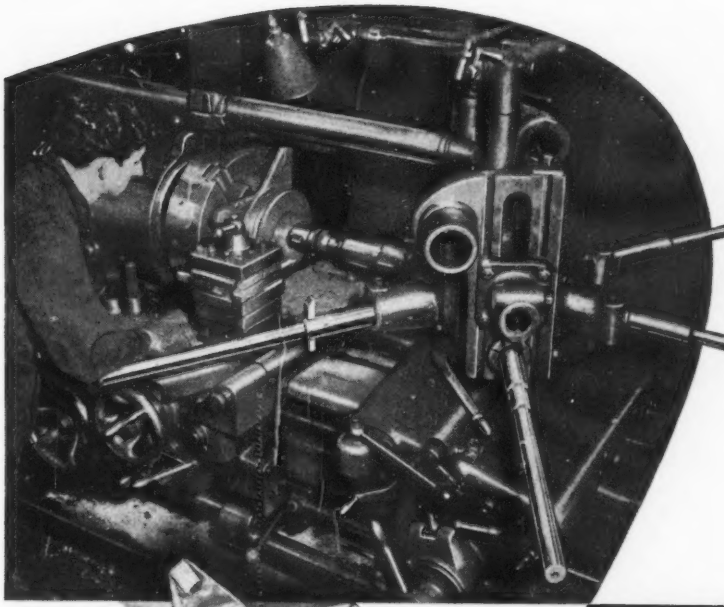

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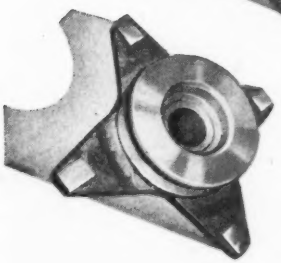
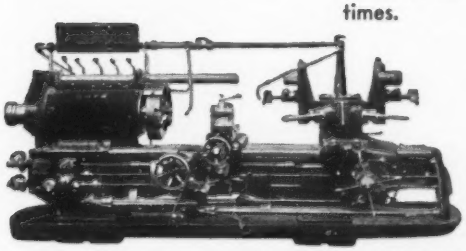


**Ward**

# COMBINATION TURRET LATHES

Reproduced by courtesy of R. H. Neal Ltd., Grantham, these photographs show a Ward No. 10 Combination Turret Lathe and the Neal crane link housing produced on it. This machine carries out 17 operations at exceptionally short floor-to-floor times.



Our complete range includes Capstan and Turret Lathes with capacities up to 35 in. swing over bed and 8½ in. diameter hole through spindle.

Please write for details.

## H. W. WARD & CO., LTD.

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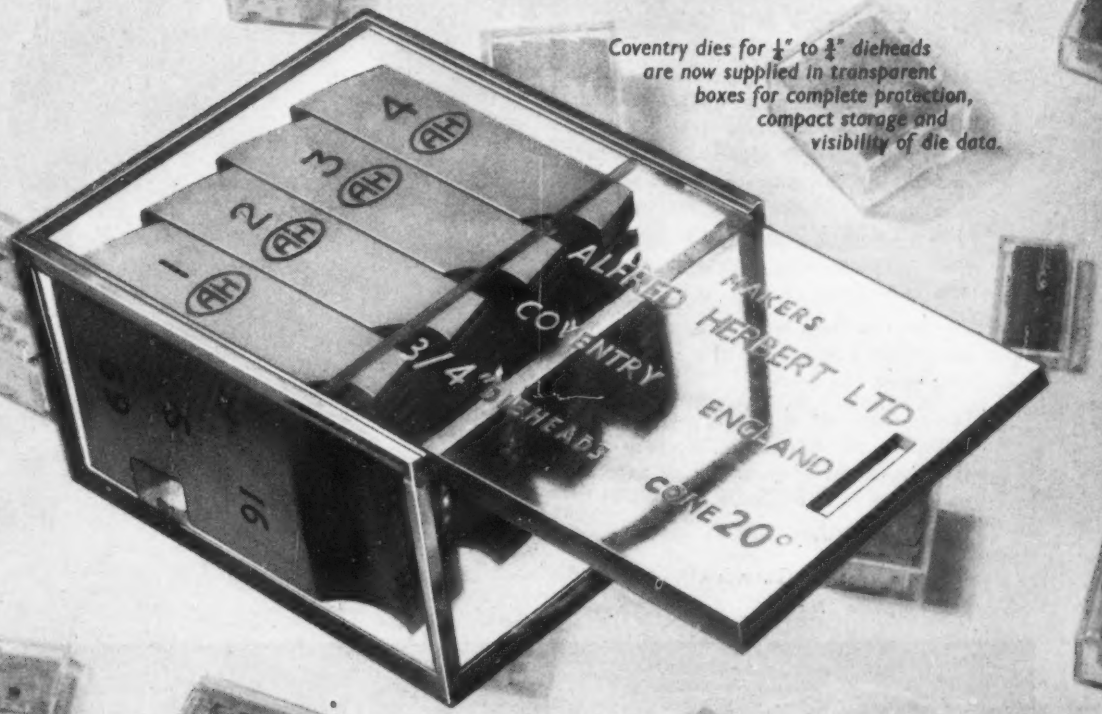
***56 years of manufacturing "Know How" ensures the quality, accuracy and long life which defeats the copyists.***




*Coventry dies for ¼" to ¾" dieheads are now supplied in transparent boxes for complete protection, compact storage and visibility of die data.*

AD.381

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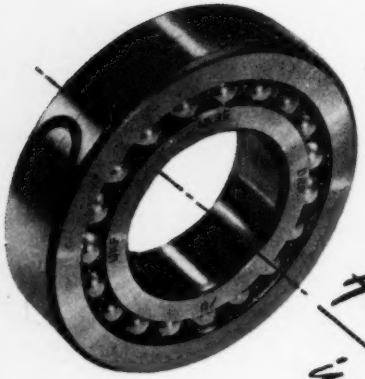
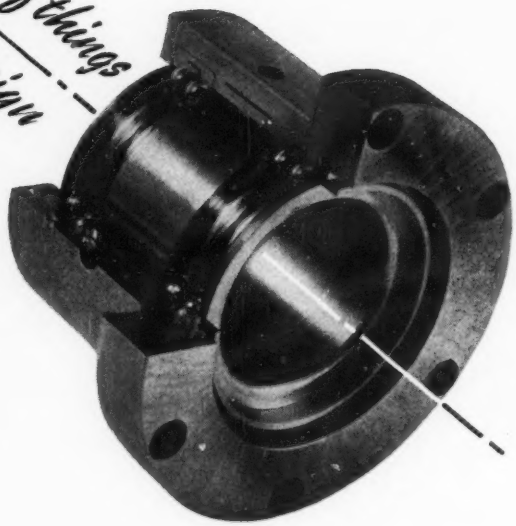


# UKF

*At the centre of things in spindle design*

## BEARINGS AND BEARING HEADS



are specifically designed for use in Machine Tools, being of unique construction incorporating three rows of balls. The two rows of load-carrying balls provide a high load capacity both radial and thrust, and the third row together with a retaining ring forms a pre-loaded rolling spacer system eliminating all radial and axial clearance.

All these features are incorporated within the standard dimensions of a conventional single-row ball bearing.

'UKF' Bearings are available in several qualities of rotational accuracy and therefore form the basis for an accurate and vibration free spindle.

Details on request.

Made in Western Germany.

***Sole Agents for the United Kingdom***

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*Designers & Manufacturers of Special Machine Tools*

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On request, we shall be pleased to arrange for one of our Technical Representatives to call and discuss your requirements in detail.

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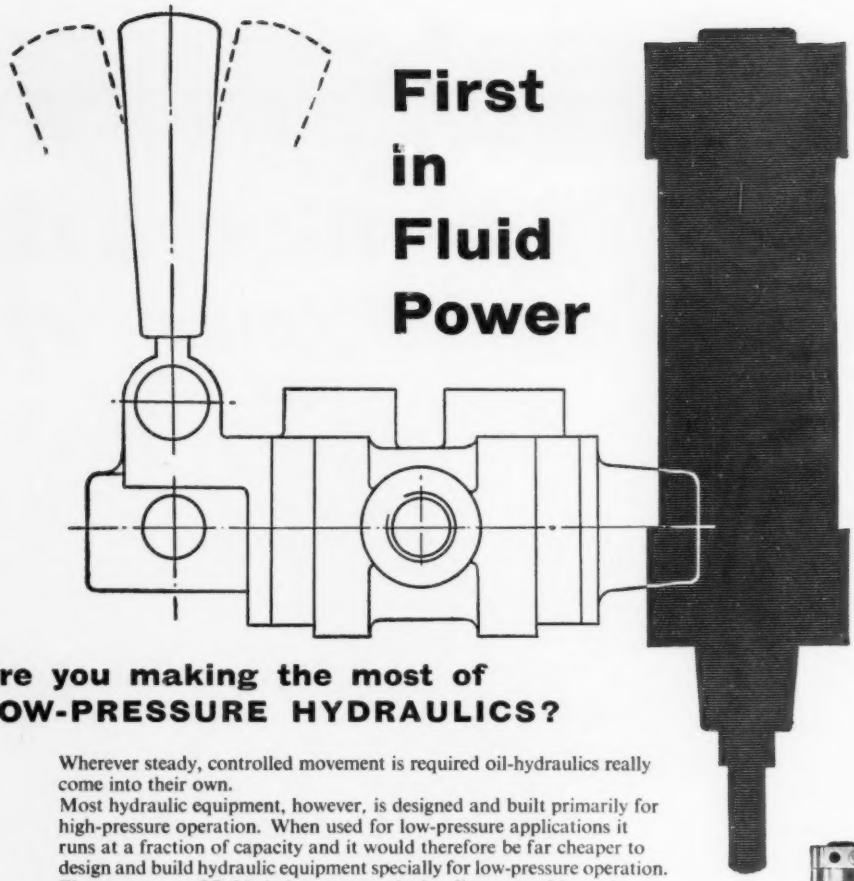

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## Are you making the most of LOW-PRESSURE HYDRAULICS?

Wherever steady, controlled movement is required oil-hydraulics really come into their own.

Most hydraulic equipment, however, is designed and built primarily for high-pressure operation. When used for low-pressure applications it runs at a fraction of capacity and it would therefore be far cheaper to design and build hydraulic equipment specially for low-pressure operation.

The new range of Baldwin low-pressure hydraulics meets this need. Right from the drawing-board stage this equipment keeps one aim in view—RELIABILITY. Polished hard-chrome plated cylinder bores and piston rods; self-adjusting oil, and water resistant seals; rugged malleable cast iron and steel construction, completely rust and corrosion proof inside and out; built-in cushioning to absorb the shock of heavy loads moving at high speeds, and many other quality design features ensure absolute efficiency even under the most arduous conditions.

Unit construction enables Baldwin to offer 432 standard types of cylinder with 6 bore sizes and 8 standard mountings.

Ask any discriminating buyer, he will tell you that it *pays* to specify Baldwin low-pressure hydraulics.

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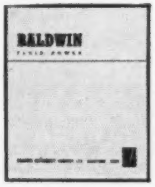
**BALDWIN FLUID POWER**




Write now for your copy of this new Fluid Power Brochure Y-503 it gives complete information on the entire range of Baldwin cylinders, valves and accessories, for pneumatic and hydraulic use.

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Tooling techniques with Araldite resins are being adopted more and more widely. Models, jigs, fixtures, patterns and metal-forming tools, including hammer forms, stretch blocks, rubber press tools, drop-hammer and draw dies, can all be made by simple methods with virtually no machining and a minimum of skilled manual work. Araldite tooling resins are used as gravity cast mineral-filled mixtures or with glass fibre mat or woven reinforcement, the latter providing strong, dimensionally stable, but lightweight surfaces and structures. Advantages of Araldite in tool-making include ease and speed of production, low production costs, light weight and ease of handling, negligible shrinkage on curing, accuracy of reproduction, dimensional stability, durability, resistance to cutting-oils and die lubricants, resistance to moisture and chemical attack, with consequent safety in storage.

*Model of part of D.H. 110 tail fin for assembly jig checking, constructed in glass fibre reinforced Araldite resin and accurate to within a few thousandths of an inch. Photo by courtesy of The de Havilland Aircraft Co. Ltd.*

The recommended techniques are simple and easily acquired. Full details and practical assistance are available upon request. May we send you a copy of our new publication on Araldite for tools, jigs and fixtures?

*Araldite epoxy resins are used*

- **for bonding metals, porcelain, glass, etc.**
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AP 327

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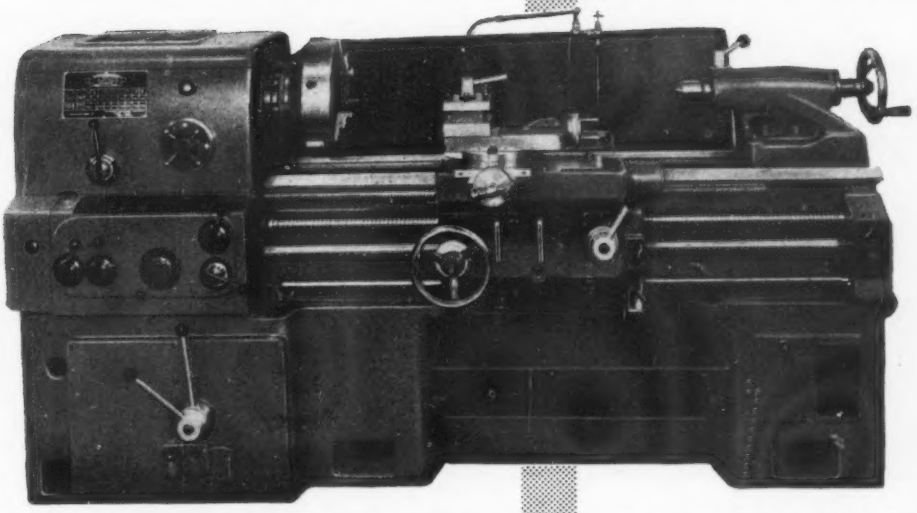
## the CARDIFF Prefect

## 9" (18½" SWING) SS & SC LATHE



## 3 1/16" SPINDLE BORE

| | | |
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| 18 | Spindle Speeds | 20-1,000 r.p.m. |
| 80 | Sliding Feeds | 0.0023"-0.232" |
| 80 | Surfacing Feeds | 0.0009"-0.096" |
| 60 | English Threads | ¼-30 T.P.I |
| 24 | Metric Threads | 0.5-30mm |

***ALL FEEDS AND THREADS OBTAINED BY SINGLE LEVER SETTINGS***

- **Gap bed 30", 48" and 80" —alternatively chip flow bed 48" and 80".**
- **Patented totally enclosed feed box.**
- **Hardened and ground gears in gearbox and headstock —all meshing faces tooth rounded for easy engagement.**
- **Patented snap action controls on apron—feeds can be varied whilst cutting.**
- **11" (22" swing) Crusader model also available.**

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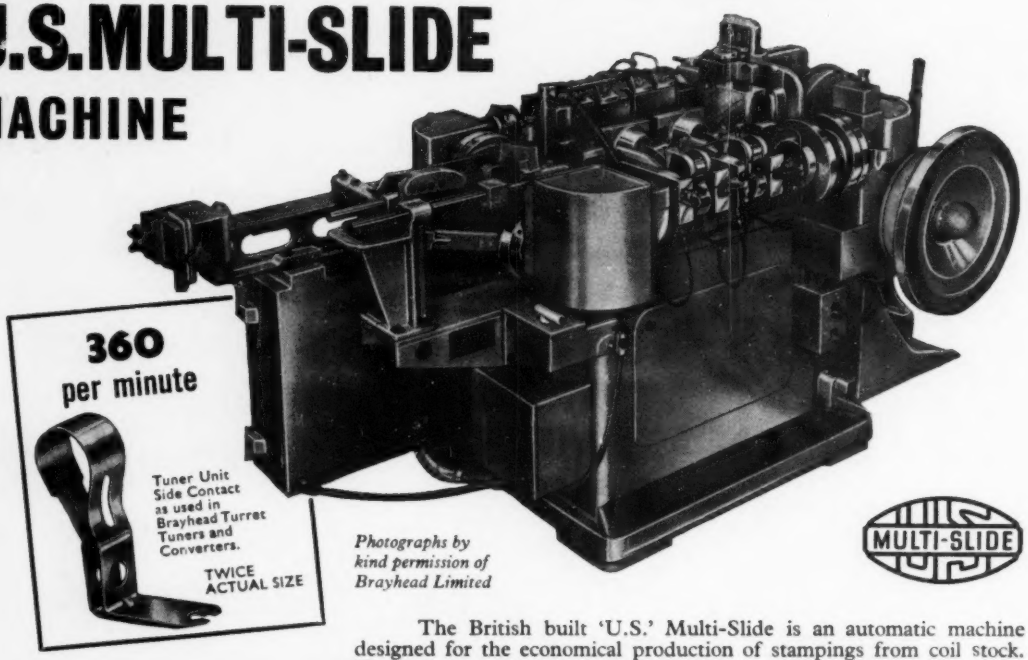
# 360 COMPLETE COMPONENTS per minute

## with the New British-Built U.S.MULTI-SLIDE MACHINE

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The British built 'U.S.' Multi-Slide is an automatic machine designed for the economical production of stampings from coil stock. The various motions provided by the die head (ram), forming slides, vertical stripper mechanism and a range of auxiliary units afford the die designer practically unlimited possibilities for the development of tools to produce stampings at considerably lower piece part cost by eliminating secondary operations and handlings.

The flow of power is smooth as operations are so timed that the load is distributed throughout the cycle. This reduces wear and greatly extends the life of the machine and tools.

The two sizes of British built U.S. Multi-Slide machines (built for us by Alltools Ltd) are now available and can be supplied completely tooled for one or more components; the tool design being based on the vast experience accumulated by the U.S. Tool Co. Inc.

Send for illustrated leaflets, also ask to see film showing operation of the machine and examples of components produced. Our Sales Engineer will be pleased to call on request.

### Brief Specifications

| Machine Model | 28 | 35 |
|---|---|---|
| Length of Feed | 8″ | 12½″ |
| Maximum Width of Stock | 1½″ | 3″ |
| Maximum Thickness of Stock | 1/16″ | 3/32″ |

*For further particulars write or telephone TODAY*

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MACHINE TOOL CO. LTD.

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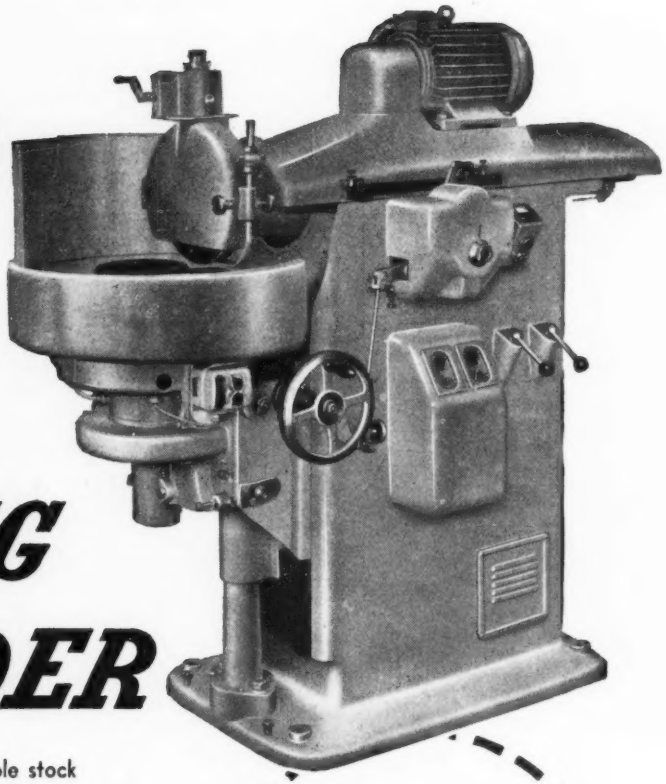
US4

# Slipmaterial Naxos

## P.M.S. 400

# *RING GRINDER*



The P.M.S. 400 gives considerable stock removal when used for roughing and superfine finish for surfacing. The grinding motor is dynamically balanced, the magnetic chuck motor is mounted on rubber, both vee-belt driven with especially rigid heavy base. The quick set-up of the workpiece on the magnetic chuck, the automatic hydraulic feed, ample grinding height and ease of control make the P.M.S. 400 ideal for many difficult grinding operations.

**TECHNICAL DETAILS**

**Max. grinding diameter ... 20"**
**Max. workpiece height ... 12"**
**Table speed ... 34 - 120 r.p.m.**
**Wheel spindle speed 2070 r.p.m.**
**Slide speed ... 0 - 67" per min.**
**Driving motor ..... 8 H.P.**

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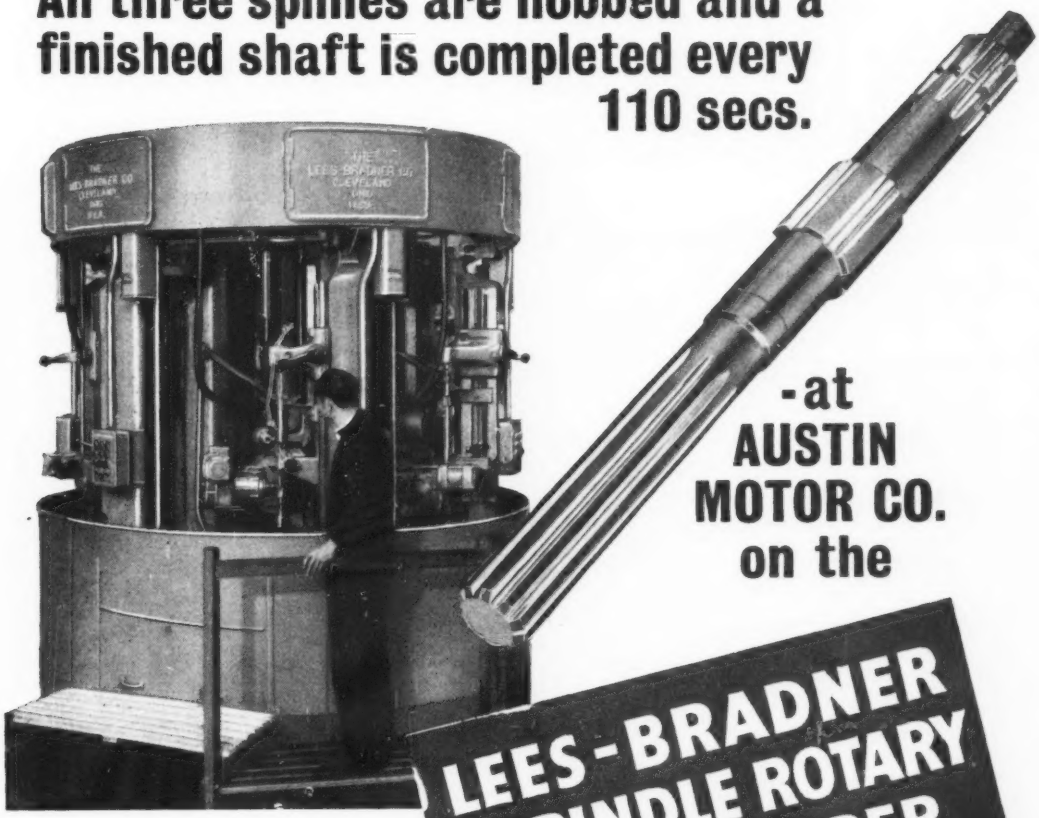
# All three splines are hobbed and a finished shaft is completed every 110 secs.



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## LEES-BRADNER 6 SPINDLE ROTARY GEAR HOBBER

★ *OUTSTANDING FEATURES*

**Automatic In-Out Mechanism**

**Automatic Closed Cycle**

**Automatic Hob Shifting with Electric Counting Mechanism**

LEES-BRADNER Rotary Hobbers are available with 4, 6 and 8 spindles. All spindles are completely independent. A different set-up can be arranged on each spindle. Automatic loading and unloading can be supplied for most components.

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## FRICTION SCREW FORGING PRESS

***With push button Programme Control***

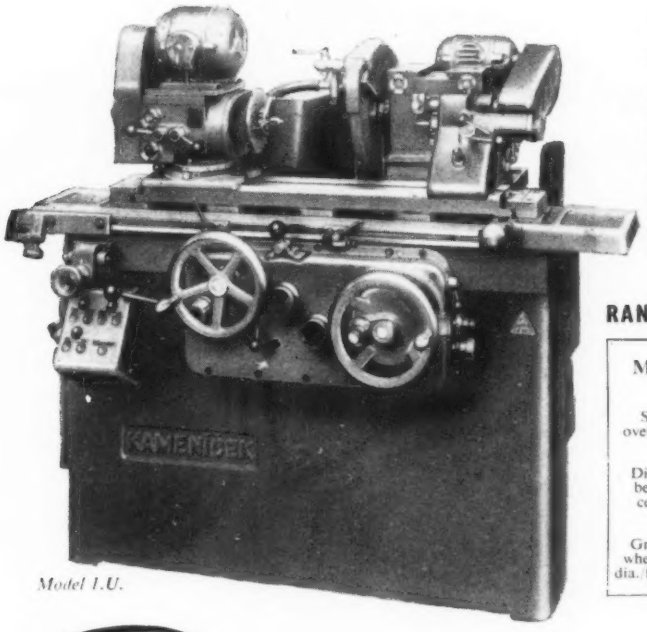
**Producing heavy pipe flanges 12" dia. bore x 19" o/d.,** from billets, in one heat and three blows.

The press is equipped with push button programme control to give blows of different strength automatically for one operating cycle.

Maximum nett energy rendered is approx. 195,000 ft./lb.

# KAMENICEK

## UNIVERSAL GRINDING MACHINES




*Model 1.U.*

Heavy duty precision built, for cylindrical (external and internal) as well as for taper and face grinding. Hydraulic table traverse; hydraulic infeed; swivelling wheel head; work-head with six spindle speeds swivels 90 degs. for taper and face grinding.

**RANGE INCLUDES:**

| Models | 1.U. | 2.U. | 5.U. | 7.U. |
|---|---|---|---|---|
| Swing over table | 10" | 11.6" | 15½" | 26" |
| Distance between centres | 15½" | 20", 30", 40" | 40", 59", 79" | 98½", 118" |
| Grinding wheel size: dia. face hole | 11.8" x 1" x 3" | 13.8" x 1.57" x 5" | 17.7" x 2" x 8" | 20" x 3" x 8" |

Selson MACHINE TOOLS

**Sole Agents.**

**Immediate Delivery from our London Showrooms**
***(Subject to prior sale)***

The Selson Machine Tool Co. Ltd
41-45 MINERVA ROAD, NORTH ACTON, LONDON, N.W.10
Telephone: Elgar 4000 (10 lines) Telegrams: Selsomachi, London, N.W.10
600 GROUP

56/SMT/167

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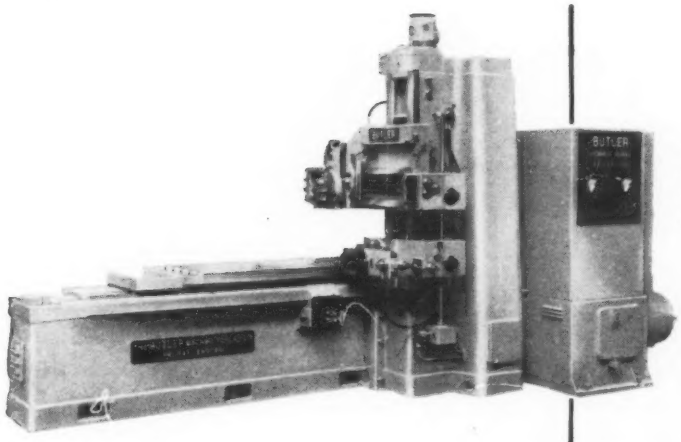
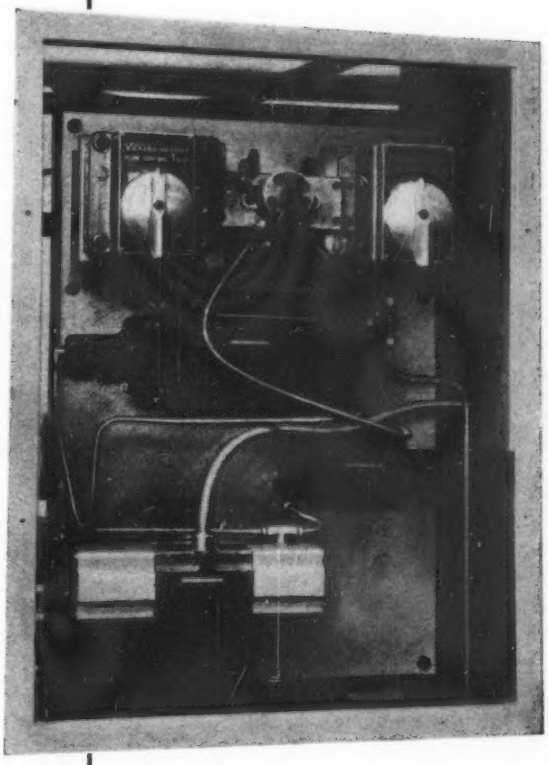



*This Butler Hydraulic Planer is a notable example of British machine tool design and construction. It is fitted with* VICKERS-DETROIT *oil hydraulics.*

## fluid assets

Throughout industry
the demand is increasingly
for machines that can repeat a cycle
of operations
with minimum manual interference
and control. It is
in this field that the flexibility
and reliability of
VICKERS-DETROIT oil hydraulics
are especially evident.
For literature on our oil hydraulic
products please write for publication
No. 1/10.



British Made
VICKERS-DETROIT
OIL HYDRAULICS

*by*

**STEIN ATKINSON VICKERS HYDRAULICS LIMITED**

**S.A.V. HYDRAULICS** **60 Buckingham Palace Road London SW1**

BAS.SAVH/10


Never satisfied! Always improving! A steady progress towards perfection—*burbled the Managing Director in his most self-satisfied voice.*

Take Pneumatic Screwdrivers. Efficient, you say—but perhaps a trifle noisy for the assembly line. Sir, you are living in the past. This Little Horse here (*" this 'ere Little Horse, if you please " muttered the Little Horse in question)* operates a screwdriver. Note that we have fitted him with a kind of gag or muffler, thus reducing the operating noise level by more than 50%. The principle is really very simple—as I will now demonstrate. I place this muffler over my mouth . . . so . . . I will now ask any member of the audience to wrap the ends—thank you, sir,—round behind my ears . . . and N'mm M'mm Er'rm Ah'rmm Hurh'mm mm-m-mm . . . !

*(The audience agreed that the noise level had indeed dropped by well over 50% and the Managing Director was carried out, black in the face, amid loud cheers).*

**These Screwdrivers are now fitted with an improved plastic grip; they are available in four different speeds:– 2,500, 1,000, 550 and 310 r.p.m. For further details write for special leaflet.**

THE NEW **DESOUTTER**
silent screwdriver

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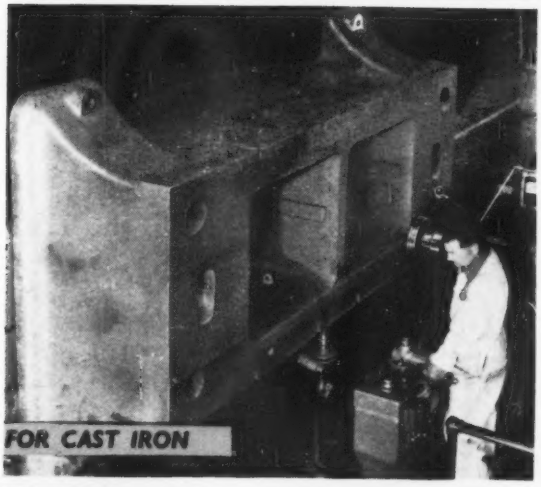
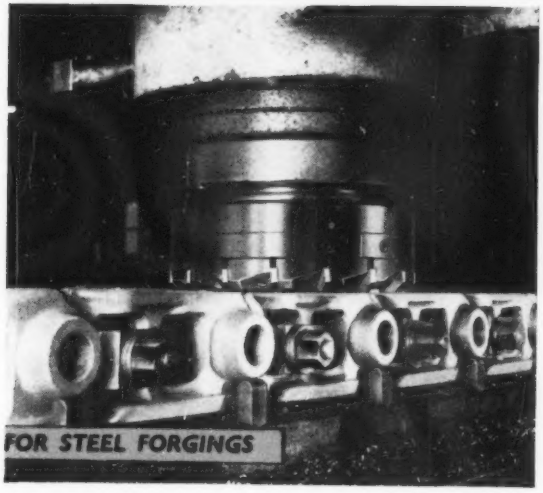


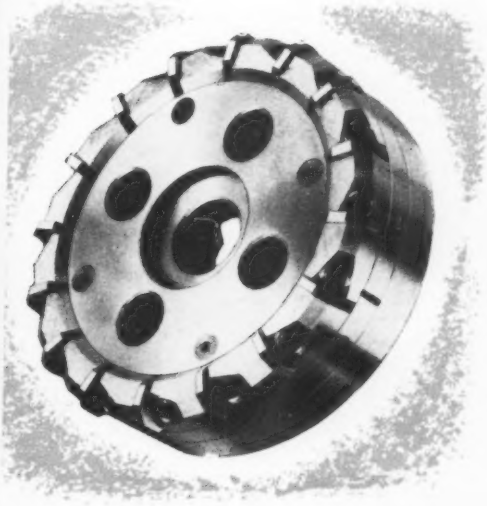




**Prolite FUTUR MILLS**

## FACE MILLING CUTTERS

incorporating these 5 unique features

- All Rake and Clearance angles incorporated in the cutter body
- Sixteen cutting faces are available before regrinding is necessary
- No time lost for blade regrinding
- Steel can be milled at high feed rates
- All inserts can be replaced without disturbing the tool setting



*Home Sales:* **PROTOLITE LTD.** *(a subsidiary company of Murex Ltd., Rainham, Essex),* **CENTRAL HOUSE, UPPER WOBURN PLACE, LONDON, W.C.1.**
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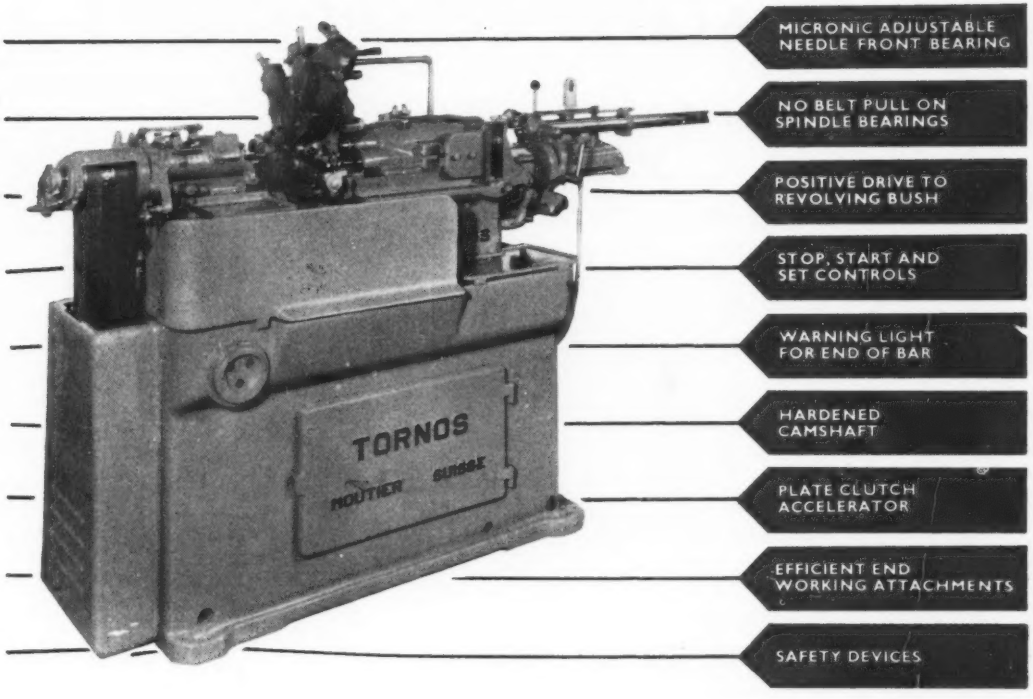
# RIGHT OUT AHEAD
## – IN PRODUCTION CAPACITY & PRECISION




This model R 16, built by the world's largest and oldest producers of Swiss-type automatics, is the last word in performance, precision and production capacity.

Stock capacity $\frac{5}{8}$in. dia., with a maximum turning length of $3\frac{1}{4}$in. or 6in., according to type of cam. 28 spindle speeds 485 to 5,450 r.p.m.

*Full details and production data gladly sent on request.*

# The latest TORNOS
## SLIDING HEAD AUTOMATIC
### MODEL R.16

PHONE: COVENTRY 40606

**TORNOS SALES COMPANY**
**BROADGATE HOUSE COVENTRY**

# *Q. What does it cost to drive a 10 kW Generator from a 14/22 h.p. Armstrong Siddeley Air-Cooled Diesel?*

## *A.* $0.01385 (1.175[d]) per kW/hour*

**ACTUAL COSTS**
**FOR 2606½ HOURS RUNNING WERE:**

| | |
|---|---|
| Diesel fuel (less tax: 1178 gals.) | $259.27 |
| Lubricating oil, filters etc. | $81.71 |
| Spare parts (fuel filter assembly) | $20.35 |
| Fuel consumption (Gals/Hour) | 0.441 |

* *Figure supplied by Gt. Raymond Paper Co. of Lac Brûlé, Canada.*

**YEARS OF KNOW-HOW:** The diesel engines are manufactured with the same precision as the Hawker Siddeley Group's world-famous aero engines.

**MATERIAL-CHECKED:** Armstrong Siddeley experts regularly visit suppliers of materials and components to check on their quality controls.

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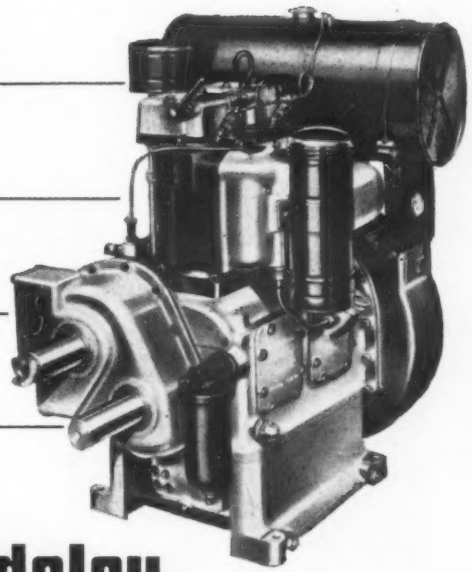
**THERE IS NO MORE RELIABLE DIESEL ENGINE.**
**Three models: 6-11 h.p., 14-22 h.p., 20-33 h.p.**
*Write now for brochures.*



# Armstrong Siddeley
## AIR COOLED Diesels

ARMSTRONG SIDDELEY (BROCKWORTH) LTD · HUCCLECOTE · GLOUCESTER

MEMBER OF THE HAWKER SIDDELEY GROUP

# CEJ CHASER DIES

***CEJ PRODUCTS***

*Ground Thread Taps*
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*Extensometers*
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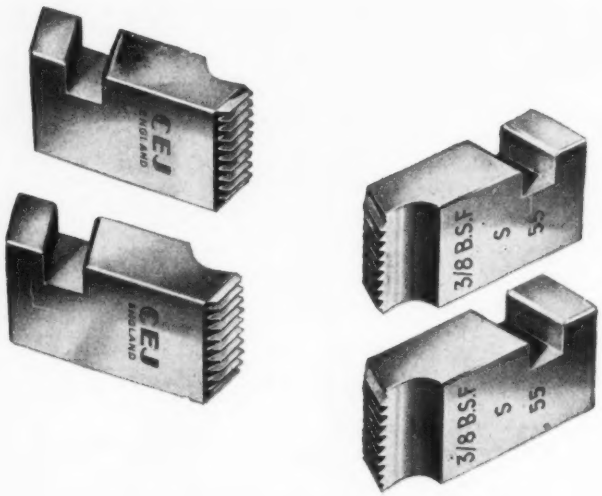
*Plain Ring Gauges*
*Gronkvist Drill Chucks*
*Dial Gauges*
*Tapping Attachments*
*Multiple Interference Microscopes*
*Vernier Height Gauges*

Everything that care and skill can contribute go to ensuring that CEJ Dies will be correct in every detail and fully meet your requirements.

They are manufactured from specially selected H.S.S. correctly heat treated; produced by the most exacting methods, rigidly inspected in all thread elements and actually tested before despatch.

CEJ Chaser Dies can be used in CEJ 430 Die Heads and Coventry and similar type Die Heads.

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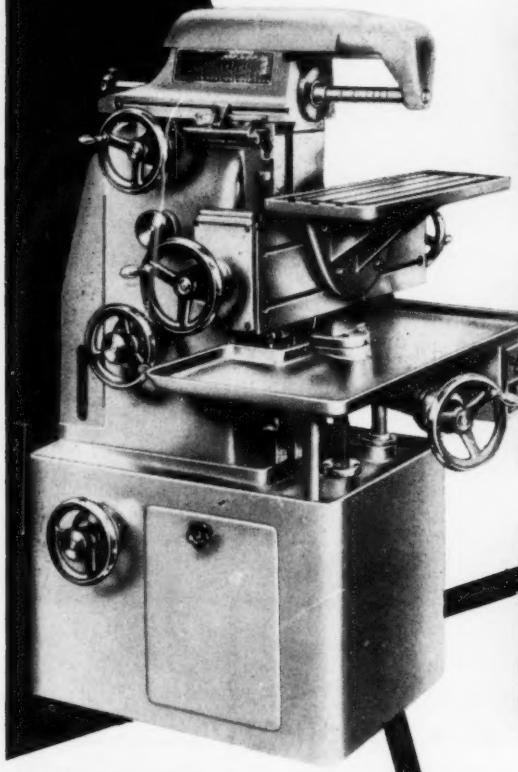
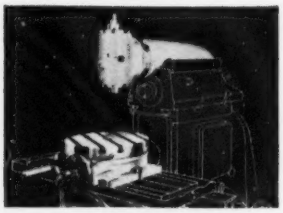
# Type U-OA Universal Milling Machine

WITH TABLE SWIVELLING IN THREE PLANES

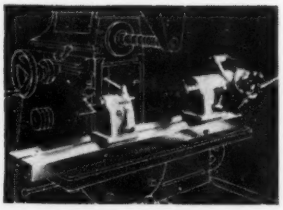
## CHRISTEN

**This modern, well-designed machine is especially suitable for Toolmaking and for high precision production work**

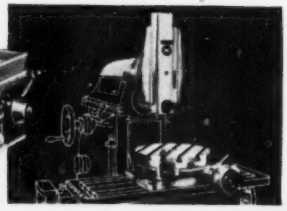




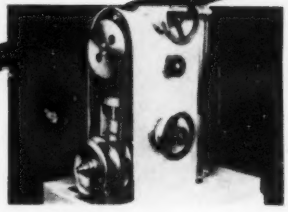
**Vertical Milling Head & Universal circular table**



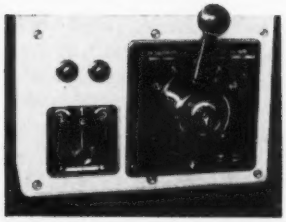
**Universal Dividing Head on auxiliary swivelling platen**



**Slotting Head & Circular Table**



**Infinitely variable speed range from 60 to 2,500 r.p.m. Infinitely variable feed from separate fitted motor**



**Patented single lever switch for easy control of milling spindle rapid traverse & power feed**

A SWISS PRECISION MACHINE

**Table Size 26¾in. by 9in.**

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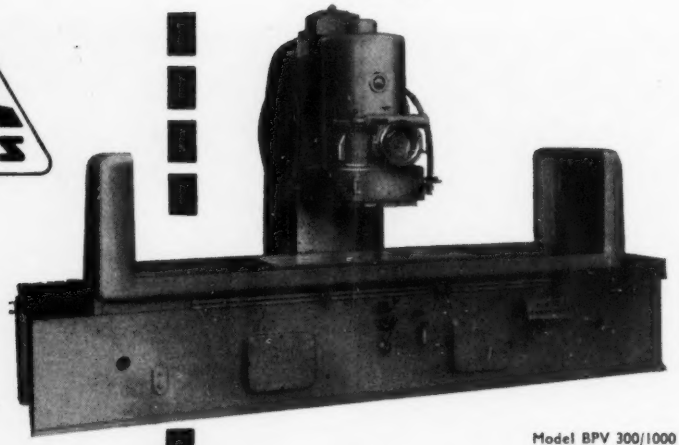

Model BPV 300/1000

# VERTICAL SPINDLE SURFACE GRINDER

*Costs less than you think*

A machine specially built for the rough and precision grinding of continuous and interrupted plane surfaces. For hollow grinding the head can be tilted out of its horizontal position.

During grinding the entire working width of the table or the surface of the electromagnetic chuck can be covered simultaneously by a segmental grinding wheel.

The BPV Surface Grinder, while costing less than many similar machines, is designed to give long and reliable service wherever there is a need for top quality accurate grinding.

| | BPV300 | | BPV700 | |
|---|---|---|---|---|
| | 1000 | 1500 | 2000 | 3000 |
| Working surface of table | *(inches) 11¾ × 39⅜ | *(inches) 11¾ × 59 | (inches) 23½ × 78¾ | *(inches) *23½ × 118 |
| Maximum width ground | 11¾ | 11¾ | 23½ | 23½ |
| Longitudinal travel of table | 54½ | 80½ | 95 | 154 |
| Main spindle drive, h.p. | 20 | 20 | 30 | 30 |

## * Delivery — IMMEDIATE

(subject to prior sale).

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*Machine Tool Division*

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Newman

# Our SMALLEST miller still a BIG machine


Nothing small about our Model 'O' range of horizontal milling machines. However hard the going, short of obvious overloading, they can take it. That's because they are solidly, generously, heavily* built for a lifetime of honest service with the absolute minimum of maintenance. 20 different variations of an extremely rigid central theme; hand or automatic feeds; large range of spindle speeds right down to 150 r.p.m. Angular contact ball-bearing spindle and ball-bearing arbor bracket allow spindle speeds up to 4,000 r.p.m.

* Weight of model illustrated 9 cwt. (1,008 lbs.). Table sizes 18½" × 5", 17½" × 5" and 12" × 4½"

*Write for fully illustrated leaflet*

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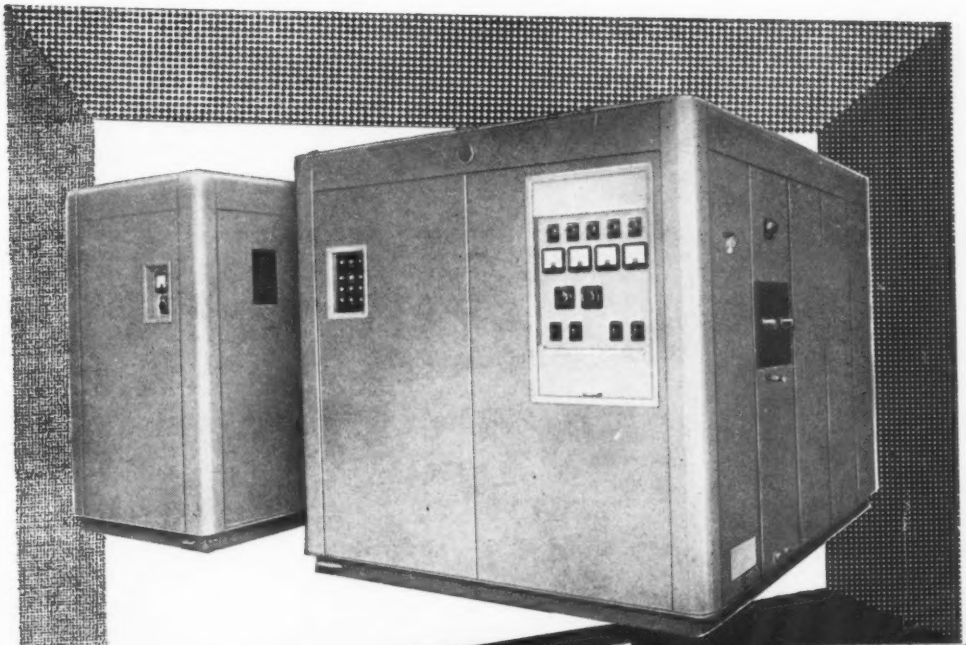
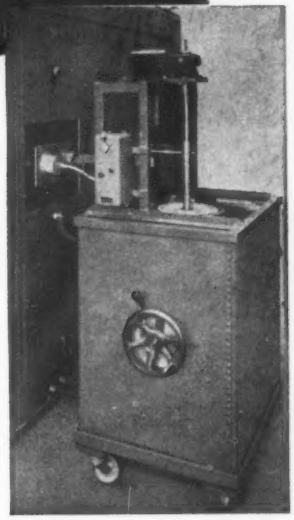
*Many Types for EARLY DELIVERY*



# Redifon IH.45

## The world's most powerful AIR COOLED R.F. INDUCTION HEATER

This new 125 kW heater has been specially designed to give reliable and continuous performance under the most arduous industrial conditions. Its efficiency is unimpaired by widely varying electrical loads or poorly regulated mains supply. And the IH.45 is air cooled . . . an economy feature no other R.F. generator of this output has ever had. Typical amongst many possible applications are one shot hardening of gears . . . hardening crankshafts, sprockets and motor car cylinder walls . . . rapid melting of Nimonic alloys . . . hardening teeth of main transmission gears for lorries . . . and tube welding. The Redifon IH.45 speeds production by reducing processing time to an absolute minimum, and is so simple to operate that it can be used by unskilled personnel.



**Heating a spur wheel for a tractor gearbox before hardening in the special Redifon quench bath.**

*Industrial Electronics Division*
REDIFON LIMITED, BROOMHILL ROAD, LONDON, S.W.18 Telephone: VANdyke 7281
*A Manufacturing Company in the Rediffusion Group*

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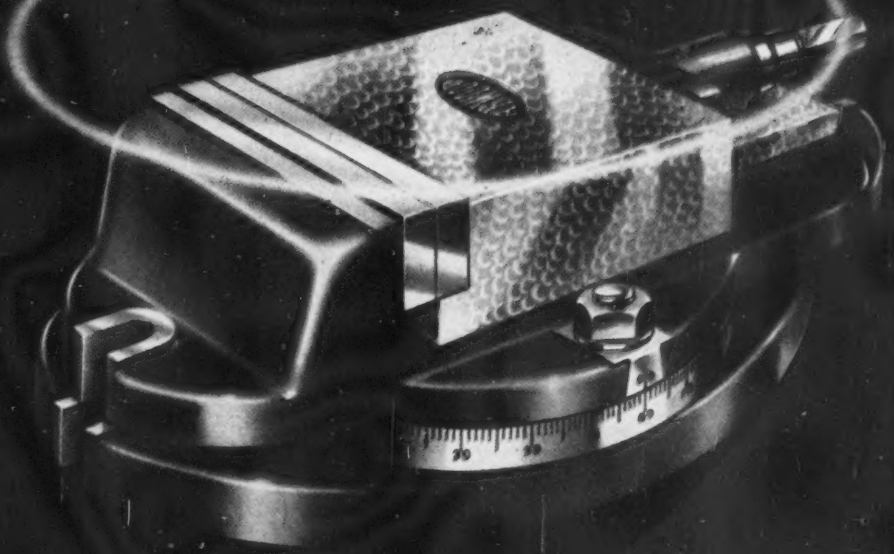
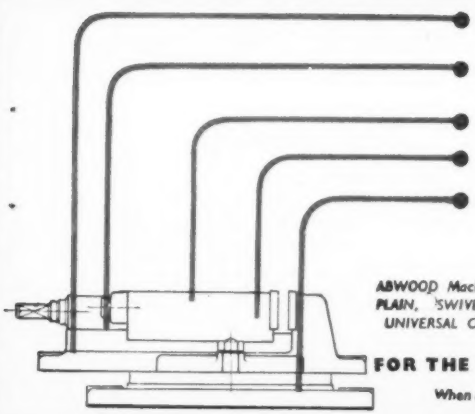
*with all the virtues*





V SLIDES ADJUSTABLE FOR WEAR. LONG BEARING SURFACES. IMPOSSIBLE FOR THE JAW TO LIFT AND TILT THE JOB.

TOTALLY ENCLOSED HARDENED SQUARE THREAD SCREW WHICH CANNOT BECOME SEIZED OR BRUISED.

SLIDING JAW MACHINED OVER ITS WHOLE SURFACE FOR THE USE OF THE SCRIBING BLOCK.

GROUND TOOL STEEL JAWS AND PHOSPHOR BRONZE NUT.

ACCURATELY MACHINE DIVIDED SWIVEL BASES INDEXED FULLY THROUGH 360°.

NO TRAPS FOR SWARF.

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AS STANDARD COMMERCIAL PRODUCTION

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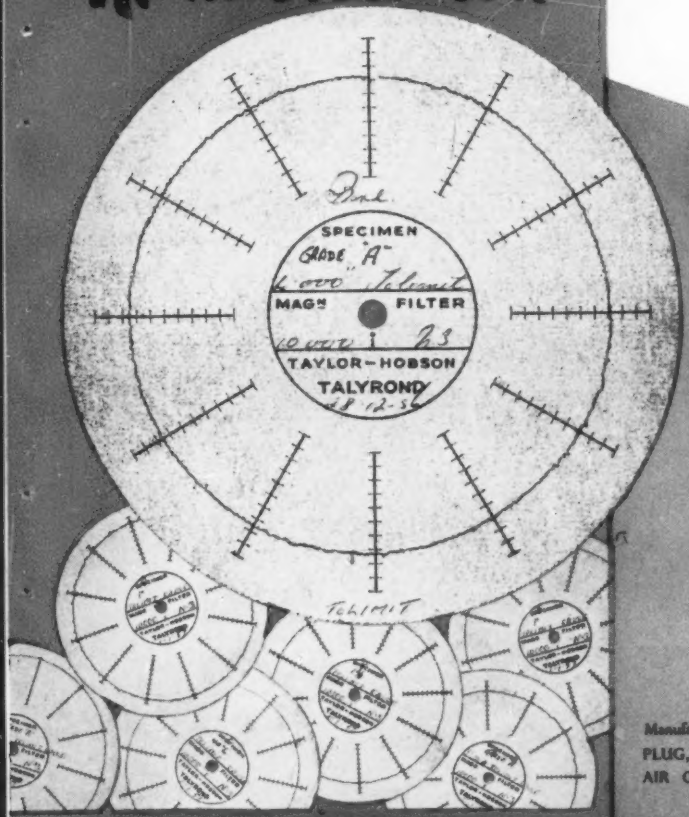


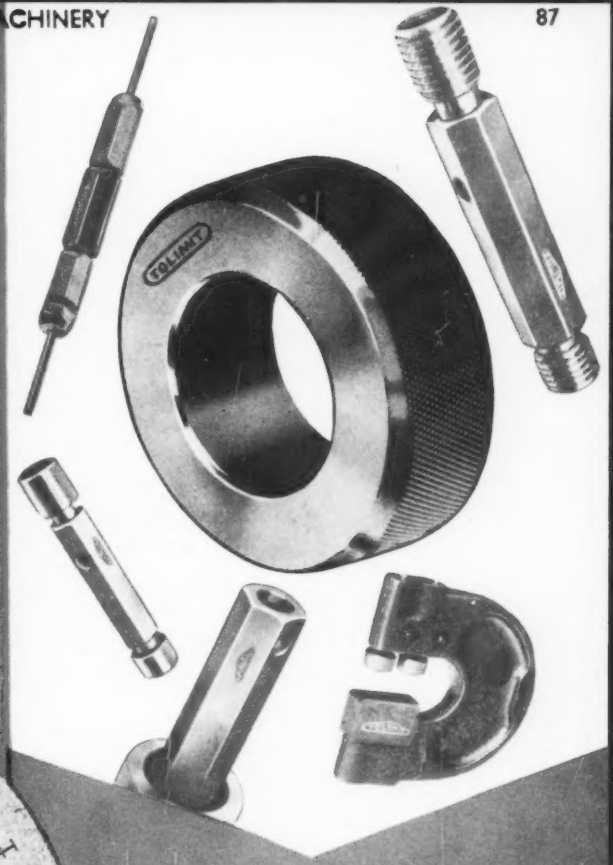


## Here's Proof

ON TALYROND CHARTS

The charts illustrated were supplied to us by a well-known Bearing Manufacturer. The chart reproduced is typical of a batch of 13 and shows a 4in. dia. Tolimit plain ring Gauge truly round within 5 millionths of an inch.

It also illustrates the high degree of surface finish. Parallelism and roundness of Tolimit Rings and Plugs are regularly made to the highest order of accuracy obtainable—anywhere in the world.

FOR LIGHT WAVE PRECISION

Manufacturers of
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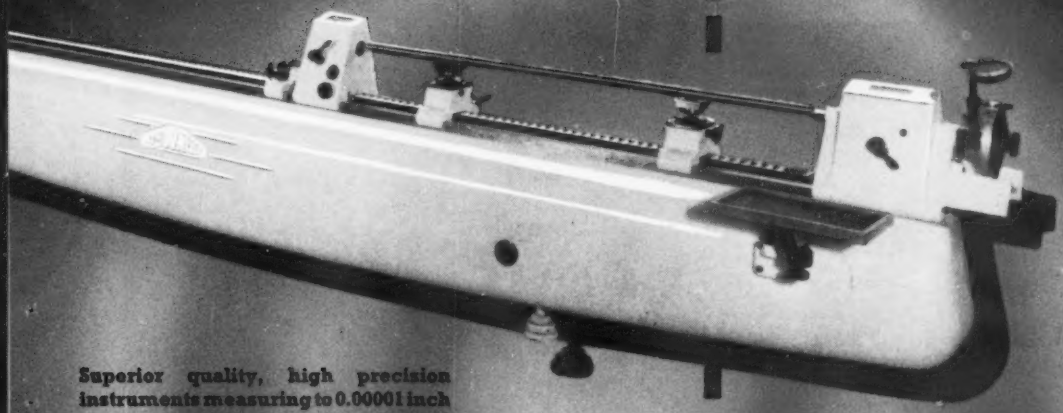
Reinhardt

# NEWALL

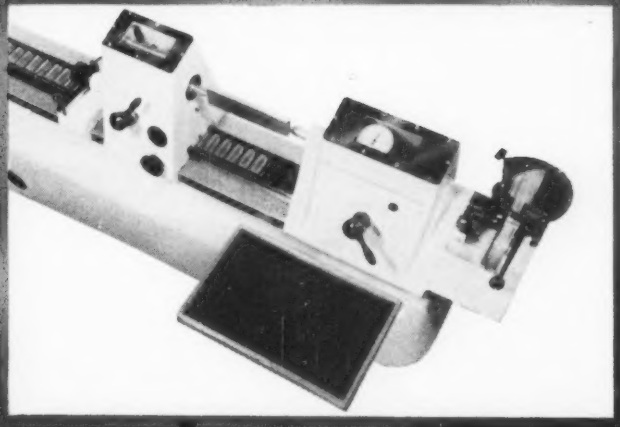
# measuring machines

*up to 144″ capacity*



**Superior quality, high precision instruments measuring to 0.00001 inch or 0.0001 mm and maintaining an overall accuracy of 0.0001″ per foot., Newall Measuring Machines are indispensable equipment for the standards room or workshop.**
**Among a wide range of applications, they are eminently suitable for originating or periodically checking gauge sizes and standards.**

**The illustration below shows set-up for checking a length bar and also details the patented Newall Measuring System incorporated in the machine.**



## SIZE RANGE

| ENGLISH | METRIC |
|---|---|
| 0 - 24″ | 0 - 600 mm |
| 0 - 48″ | 0 - 1200 mm |
| 0 - 72″ | 0 - 1800 mm |
| 0 - 144″ | 0 - 3600 mm |

*A PRECISION PRODUCT OF*
**OPTICAL MEASURING TOOLS LTD**
*MAIDENHEAD BERKS*

***full details on request to***

# NEWALL GROUP SALES LIMITED

**PETERBOROUGH ENGLAND**

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# MACHINERY

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Vol. 92, No. 2357 January 17, 1958

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## CONTENTS

# Abstracts of Principal Articles

## The British Timken New Building Project ..... P. 120

At the highly-mechanized N.B. plant of British Timken, Ltd., Duston, cups, cones, and rollers for tapered-roller bearings are finished on separate lines. From the hardening department, cups are passed into storage hoppers, whence they are fed to a Gardner machine for grinding both end faces. The ground cups are next delivered to two parallel lines, equipped with similar machines. Each line incorporates Cincinnati centreless grinding machines for finishing the outer surfaces; Heald Centrimatic machines for finish grinding the bores; and Timken machines for lapping the bores, the latter employing abrasive tape as the finishing medium. After they have been finished, cups are inspected and washed, before mating inner race units are assembled. Cones are similarly treated, and pass through a Rowland duplex face-grinding machine, thence to two lines of Cincinnati, Heald and Timken machines for finishing the bore, roller track, and rib. Washing and inspection follow, before the cones are assembled to rollers and cages on semi-automatic machines. Hardened and tempered rollers are delivered to the finishing lines from the main factory, and pass through Cincinnati centreless grinders, Timken spherical-end grinding machines, and washing and drying units, to mechanized inspection stations. They are finally graded, before they are passed to the adjoining section for assembly to cones. Various interesting work-feeding, distribution and re-orientating units have been developed to facilitate the flow of cones and cups through the plant. (MACHINERY, 92—17/1/58.)

## The Re-servicing of Carbide Tools...P. 136

The economic advantages of tungsten carbide tooling can be fully realized only by careful attention to the correct methods of servicing, employed at the correct times. In this article, attention is first drawn to the structure of tungsten carbide and its implications. Grinding wheels and their cutting action are discussed, with particular reference to diamond wheels. A section is devoted to off-hand grinding and its applications, including the sequence of operations to be followed and the modification of standard tools. Machine grinding is subsequently considered, and various typical operations are described in detail and illustrated. These operations are concerned, for example, with the production of a parting and chamfering tool from a standard bar tool, and the sharpening of end mills and milling cutters. Other subjects covered include chip breakers, the re-servicing of tools by spark-erosion, and surface finish and the cutting edge. (MACHINERY, 92—17/1/58.)

## Typical Operations on Components for Piatti Motor Scooters..... P. 149

The Piatti motor-scooter made by Cyclemaster, Ltd., is equipped with a horizontally-mounted 2-stroke engine. Operations on some of the principal components for this engine are here described, including the final drive spindle, which is turned in two stages on multi-tool lathes. Subsequently, the spindle is drilled, slotted, and serrated and threaded by rolling. Multi-tool lathes are also employed for the crankshaft, on which threads and oil grooves are later formed by rolling. To ensure accurate concentricity, serrations are cut on a gear generator, and the shaft is selectively hardened by the induction process prior to finish grinding. For drilling and tapping the components of the light-alloy split casing, horizontal, 2-way multi-spindle machines are employed. Other set-ups described are concerned with fine-boring operations on the cylinder, connecting rod, and front suspension arm. (MACHINERY, 92—17/1/58.)

## Measurement of Paint Thickness on Aircraft ..... P. 156

It is pointed out that in addition to being smooth, the paint layer on a high speed aircraft must be of uniform thickness within close limits. Reference is made to various methods of thickness measurement, and the manner in which a Boonton film gauge has been modified for this purpose, by the Martin Co., U.S.A., is then described. A meter is set to zero with the aid of a sample, and is calibrated to show paint thickness in thousandths of an inch. (MACHINERY, 92—17/1/58.)

## Baldwin Automatic Control System for a Rolling Mill.....P. 157

A Robertson cold-strip rolling mill, installed in the works of D. F. Taylor, Ltd., Birmingham, has recently been equipped with the new Baldwin nucleonic automatic gauge-control system. With this system, which depends on bremsstrahlung radiation produced by the emission of beta rays from a strontium 90 source, material thickness ranging from about 0·004 to 0·4 in. can be checked. With the installation here described, the strip thickness is accurately and continuously measured, and is controlled by automatic adjustment of the roll setting. In addition, the thickness is continuously recorded on a paper chart, and is indicated on a dial type meter. Reference is also made to the method of calibrating the gauge. (MACHINERY, 92—17/1/58.)

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## Contributions to MACHINERY

If you know of a more efficient way of designing a tool, gauge, fixture, or mechanism, machining or forming a metal component, heat treating, plating or enamelling, handling parts or material, building up an assembly, utilizing supplies, or laying out or organizing a department or a factory, send it to the Editor. Short comments upon published articles and letters on subjects concerning the metal-working industries are particularly welcome. Payment will be made for exclusive contributions.

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## IN FORTHCOMING ISSUES

**The production of components for Lambretta motor scooters—Heavy bending operations.**

# Women in Engineering

Although women have been employed for certain duties in engineering works and similar establishments for many years, they are seldom—in this country—engaged in the type of work that falls within the province of the professional engineer or technologist. In view of the contributions that women have made to progress in other scientific fields, there does not appear to be any valid reason why they should not undertake the most exacting duties in those branches of science and technology associated with engineering, provided that they have acquired the necessary training and experience.

Any form of engineering or technological education should be based upon practical training. At one time, the arduous physical labour involved in an engineering apprenticeship, or similar programme of training, might have deterred women from embarking on an engineering career. In the past, when heavy engineering was the backbone of our industry, such a view was justified. Conditions have improved, however, and, in progressive works, much of the heavy manual labour formerly required has now been eliminated by the introduction of mechanical appliances and handling aids on an extensive scale. Due to changes in the industrial pattern, moreover, the light and medium engineering industries occupy very important positions in the economic structure of this country at the present time. For these branches of engineering, the practical training, although exacting, is not so arduous as to be beyond the physical capabilities of young women. These branches, moreover, include industries that specialize in the production of domestic and other equipment, to which women should be able to make a particularly useful contribution.

Although the rigours of practical training should no longer deter women from embarking on engineering careers, the specialized education—both practical and theoretical—that is necessary, calls for certain sacrifices, principally in initial earning power and leisure. Such sacrifices will only be made when there is reasonable certainty that the future will afford ample compensation. Clearly, conditions of employment must have some influence, but actual working conditions need not concern us here, since it is now generally accepted that engineers and technologists, whether male or female, can only work at their optimum efficiency in good conditions, and offices and laboratories in modern engineering establishments are of a very high standard. Other conditions must be made equally attractive if women are to be persuaded to enter the engineering profession in any numbers. It is essential, therefore, that once they have acquired the same training and experience, women should be treated as the equals of their male colleagues, not only as regards pay, but in other directions. They should not be employed merely for routine duties, but should be given work that affords full scope for the application of judgment, imagination and initiative. Equality, moreover, should extend to status, responsibility, and opportunities for promotion, up to the highest levels.

The entry of large numbers of women into the engineering and allied professions will introduce certain problems, not the least of which will be concerned with marriage. Any employer may justifiably be filled with misgivings at the prospect of losing a promising young woman engineer at the time when, after an extended period of training, she is starting to make a really worthwhile contribution to the progress of his company. It would clearly be undesirable that women should forgo marriage for the sake of a career in industry, but many would doubtless be prepared to continue working after marriage until the demands of home and family became too pressing. As with other professions, moreover, an engineering career need only be interrupted by marriage, and not ended, and provided that the work was sufficiently stimulating and rewarding, many women would probably be willing to resume their careers after a few years. It would then be necessary to arrange for them to undergo some form of refresher course, in order to bring their knowledge up to date, and to restore skills, which might have been temporarily lost, to their former efficiency. Such courses would need to be of only limited duration, however, since knowledge and skill, once thoroughly acquired, are seldom completely lost.

If British industrial expansion is not to continue to be hampered by a lack of trained technical workers, it is generally agreed that the numbers of qualified engineers and technologists must be doubled in the next ten to fifteen years. It is obvious, therefore, that we cannot afford to neglect any source of high-quality recruits, yet the pro-

(*Continued on page* 167)

# The British Timken New Building Project

***Automatic Production Facilities for the Manufacture of Tapered Roller Bearings in Large Quantities***

In MACHINERY, 92/4—3/1/58, were given some details of the highly-mechanized production facilities which have been established by British Timken, Ltd., Duston, Northants, for the manufacture of certain of their tapered roller bearings in very large quantities. It may be recalled that the N.B. Plant, as it is known, is designed for a maximum output of 5-million assembled bearings per year, although at present the output rate is 3-million per year.

The N.B. Plant is housed in a modern building separate from the main works at Duston, and has its own service installations—for example, for heating, swarf disposal and cutting oil reclamation. There are three main departments, which provide for the production of cup and cone blanks, on single and multi-spindle automatics; for heat-treatment of the blanks, by carburizing, hardening and tempering; and for grinding cups, cones and rollers, assembling these components with cages to form finished bearings, greasing, and packing.

In the article mentioned, operations on cups and cones were followed, in detail, to the end of the heat-treatment cycle. At this stage, the hardened and tempered parts are shot-blasted, and then are ready for grinding. Cups and cones are delivered to separate storage hoppers at one end of the grinding department, which, it may be noted, is divided into three sections for finishing cups, cones and rollers. In the sections for cups and cones, there are two distinct machine lines, one for large, and the other for small, workpieces. The layout of the department is shown diagrammatically in Fig. 1 (which is part of the layout of the whole plant included in the first article), and the hoppers for cups and cones may be seen at the right.

## CUP-GRINDING LINES

The storage hoppers are arranged in groups of four, and are generally similar to those installed between the automatics shop and the heat-treatment department. Hoppers for cups are indicated at S in Fig. 1. Large cups are delivered to two of these hoppers directly from the Timken-built shot-blasting machine in the heat-treatment department, whereas the small cups, after being shot-blasted in the main factory, are loaded into a small intermediate hopper in that department, whence they are delivered by elevator and chute to the other hoppers in the group S. Each hopper has sufficient storage capacity for one week's work, and this reserve of parts facilitates change-overs, and provides an allowance for any interruptions in production which may occur in preceding departments. Normally, it may be noted, the full

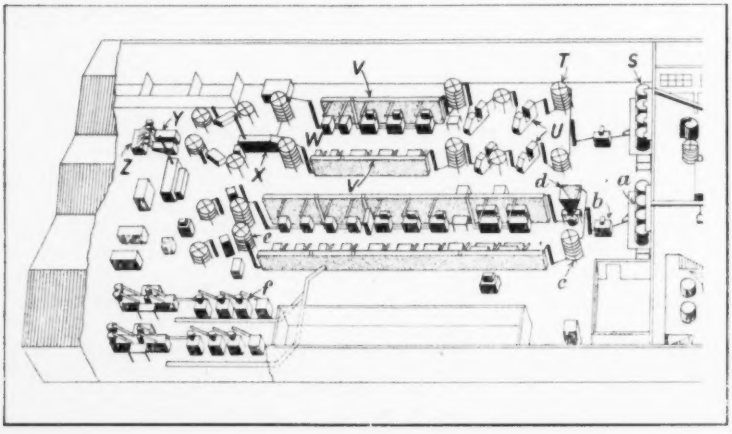


**Fig. 1. Diagrammatic Layout of Part of the N.B. Plant at the Duston Factory of British Timken, Ltd. Cups and Cones Flow from the Hardening Department at the Extreme Right, Through the Finishing Lines, to the Packaging Section at the Upper Left**

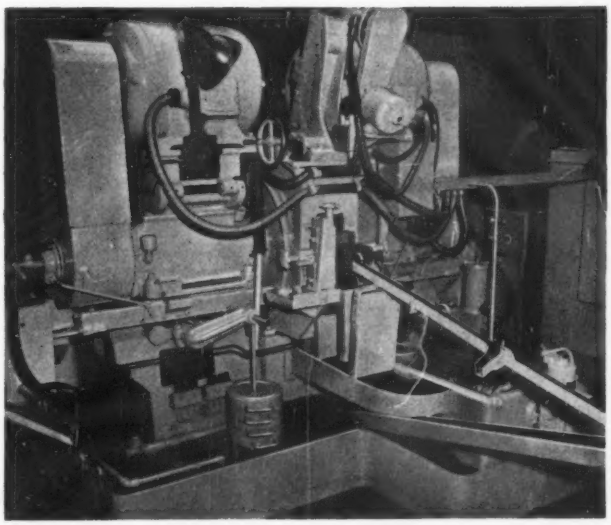

**Fig. 2. The Gardner Twin-disc Machine for Grinding the End Faces of Cups. It is Operated on an 8-hour Shift, and Supplies both Cup-finishing Lines**

capacity of the hoppers is never used.

Cups are fed automatically from the hoppers by vibratory feeders, and pass on to belt conveyors which deliver them to a gravity-feed chute. This chute serves a Gardner type 125 twin-disc machine for grinding the end faces, to finish the cups to width. The cups pass under motor-driven brushes before they enter the chute, and the latter incorporates equipment for turning the workpieces through 180 deg., if necessary, to ensure that all enter the Gardner machine with their broad ends facing in the same direction. Limit switches and associated equipment are fitted to maintain an adequate head of parts in the chute, thus ensuring that the cups are delivered satisfactorily to the power-driven rolls, whereby they are fed between the wheels of the grinding machine.

The outlet side of the Gardner machine is shown in Fig. 2, and it is provided with air-gauging equipment which is used to control the in-feed mechanisms for the grinding wheels. Since each workpiece has one wide and one narrow face, the rates of wheel-wear differ. Compensating arrangements are incorporated, therefore, and one grinding wheel is advanced at more frequent intervals than the other. A tolerance of 0·002 in. is specified for the width of the cup, but a much closer tolerance is maintained in practice, with the aid of the automatic sizing equipment. The machine has a self-contained coolant system, with a magnetic clarifier unit, the latter being visible at the right in Fig. 2.

Other machines in the cup-grinding section, also in the sections for finishing cones and rollers, are supplied with coolant from a bulk source. This centralized coolant supply is housed in a service block, adjacent to the N.B. building, and coolant is delivered by pipes in a main service trench that links the block with all the grinding sections, and also houses the return lines. In the service block, there are settling tanks, and a battery of magnetic drum clarifiers to clean the coolant, also large capacity pumps for its distribution.

Cups pass from the Gardner machine, down a chute, to a vertical peg-type elevator, which delivers them to two gravity-feed chutes serving 4-deck spiral feeders. The Gardner face-grinding machine is operated for one 8-hour shift each day, and supplies both cup-grinding lines. Cups of one particular size are face ground as a batch, and a change-over is made about three times in two days. Change-overs are carried out, on this and other machines in the section, by a setter and an operator acting as a team, and it is planned eventually to train the staff in the New Building so that they will be able to undertake the change-over and setting of any machine, or piece of equipment, in the grinding, heat-treatment, or automatics departments.

## SPIRAL BRUSH-FEEDER

The elevator associated with the Gardner machine may be seen in the foreground of Fig. 3, which is a general view of the two cup-grinding lines. The spiral brush-feeders served by the elevator are indicated at *T* in Fig. 1, and one of these feeders is similarly indicated in Fig. 3. Cups pass up the elevator with their side faces parallel to the rows of grinding machines, and, in order that they may roll into the brush feeders, are re-orientated through 90 deg., by a standardized Timken cage-type unit *A*. A deflector below this unit directs cups to the right- and left-hand chutes as required, and the chutes connect the elevator with the upper decks of the brush feeders. These feeders are typical of the units employed throughout the N.B. plant, and their construction will be described with reference to that seen at ***T***.

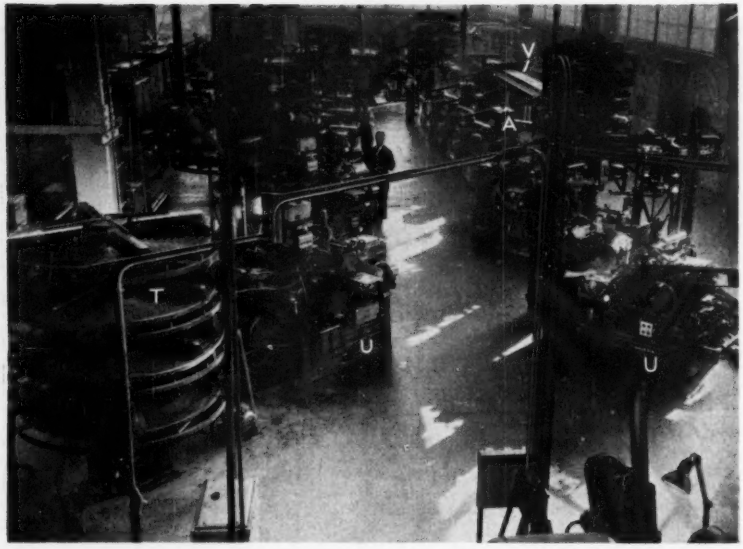


**Fig. 3. A General View of the Cup-finishing Lines. Cups are Delivered from the Gardner Machine to 4-deck Spiral Brush-feeders, One of Which May be Seen at the Left**

As will be observed, the decks of the feeder are of circular form, and each has a spiral track. The track of the upper deck is connected, at its periphery, with the gravity-feed chute from the elevator, and leads towards the centre of the deck. Here, it joins another gravity-feed chute, which, in this instance, leads to the start of the spiral track of the second deck. On a single-deck feeder, however, the chute may lead to an adjacent machine. The inner end of the spiral track of the second deck is connected, by chute, to the start of the track on the third deck, and, similarly, the track of the third deck to the track of the fourth deck. A vertical shaft, passing through holes at the centres of the decks, is driven, through a reduction gear box, by a motor below the bottom deck. The shaft carries 4-arm spiders, each spider being positioned above one of the feeder decks. Secured to the arms of each spider are soft-bristle brushes, similar to a domestic broom head, and as the shaft is rotated, the brushes sweep the workpieces in the spiral track of each deck from the inlet chute towards the outlet chute at the centre. A light pressure is applied to the workpieces by the bristles, and is adequate for feeding purposes. When the tracks in the decks become full of parts, however, the bristles are deflected and pass over the workpieces without causing damage. As the brushes rotate continuously, workpieces are directed from the inlet chute of the top deck, downwards to the bottom deck, and as the stock of parts builds up, each deck is filled in turn.

The two 4-deck feeders *T* deliver cups by way of elevators and chutes to a Cincinnati No. 3 centreless machine at the head of each grinding line. These machines are shown at *U* in Fig. 1 and 3, and provide for first-pass grinding the cups, externally. Both machines are fitted with automatic loading arrangements which will be described later. The feeder indicated at *T* in Fig. 3 serves the line for grinding the smaller cups, and the end faces of these cups are of such a width that it is necessary to ensure that alternate cups are delivered to the Cincinnati machine with their broad and narrow faces leading, in order to prevent "riding up" and jamming in the machine throat or the automatic loading mechanism. A re-orientating unit, developed by the company, is installed between the outlet chute from the bottom deck of the feeder and the associated elevator, and this unit is shown in Fig. 4.

## AUTOMATIC RE-ORIENTATING UNIT

Supported on a floor-mounted, sloping platform, the unit embodies an indexing drum *A* in a cylindrical housing. An aperture in the housing allows cups to pass into a slot in the drum from the chute *B*, connected to the lower deck of the brush feeder. There are two other apertures in the housing, which provide for communication with the ends of the horseshoe-shaped trough *C*. This trough is of U-section, and at the lower end of the horseshoe a slot is cut in the bottom of the U-form and leads to the delivery chute *D* for the elevator serving the Cincinnati machine.

A pinion is secured to the lower end of the shaft of the indexing drum *A*, and meshes with a sliding rack *E*, a bracket on the outer end of the rack being coupled to the piston rod of an air cylinder. Pressure-air is directed by a valve to each end of the cylinder alternately, and this valve is actuated

by means of a cam, driven by the motor *F*, through an integral reduction gearbox. The arrangements are such that the drum *A* is oscillated continuously through 240 deg., so that its slot moves from a position in line with one end of the horseshoe trough, past the aperture associated with the chute B, to a position in line with the other end of the trough.

As the slot passes the aperture, a cup rolls into it from the chute, and is delivered to the right- or left-hand side of the horseshoe trough. The cup then rolls round the trough, and drops through the opening at the bottom of its curved form, into the chute D. Cups enter the slot in the drum with their broad side faces to the left, and are passed to the ends of the horseshoe with these faces to the right. A cup delivered to the right-hand side of the horseshoe passes through the opening leading to the chute *D* with its broad face away from the drum *A*, whereas a cup delivered to the left-hand side passes through the opening with its broad face towards the drum *A*. Thus, cups pass down the chute *D* with their broad faces to the right and left, alternately.

## FEED ARRANGEMENTS FOR CENTRELESS GRINDERS

From the lower end of the chute *D*, the cups are lifted by a standard Timken peg-type elevator, and are discharged into an inclined chute leading to the loading mechanism of the Cincinnati No. 3 centreless grinder. Cups are fed into the machine throat along a trough, and it is important that a steady feeding pressure should be applied, since irregular pressure would result in an uneven finish on the external surfaces of the cups. Moreover, if the cups were not maintained in a "solid" stack in the trough, they might swing sideways, so that their outside surfaces were not ground square with their end faces. The feed mechanism was designed by the Timken Roller Bearing Company, U.S.A., and similar arrangements are provided on the machines for grinding large and small cups, the equipment on a machine for large cups being shown in Fig. 5.

The chute leading from the elevator is indicated at *G*, and its lower end, which is free to pivot, is connected to the moving carriage *H*. This carriage is fitted with rollers, and moves on one flat and one vee guideway on a bracket secured to the grinding machine base. A third guideway is provided for the roller of a support *J*, for the swinging portion of the chute *G*. A constant force is applied to the carriage by a cable and weight system, so that it is urged towards the grinding throat of the machine. During initial setting and loading, or when adjustments are being made, the carriage can be held in the position shown, by means of the latch piece *K*.

A trough *L*, of V-form, is disposed parallel with the guideways and extends into the grinding throat. The outer end of this trough is located beneath the downwardly-curved extension of the chute *G*, and cups pass down the chute into the trough. Secured to the under-side of the carriage is an f.h.p. motor *M*, with an integral reduction gearbox, for driving a cam which oscillates a mushroom-head pusher in line with the trough *L*.

The carriage is urged towards the grinding throat by the action of the weight and cable system, and the mushroom-head pusher applies a constant feeding pressure to the stack of cups in the chute *L* (shown empty in Fig. 5). As the carriage moves forward, it contacts an adjustable stopscrew *N*. In this position, one of two striker screws on the carriage trips the switch *P* to engage the motor drive. Oscillated by the cam, the pusher thrusts against the stack of cups, and forces the carriage outwards, a constant pressure still being applied to the stack by the weight. At the front of the carriage, there are three spring-loaded pawls which engage the outermost cup of the stack to hold it square, and to maintain the feeding pressure when the pusher is withdrawn by the cam.

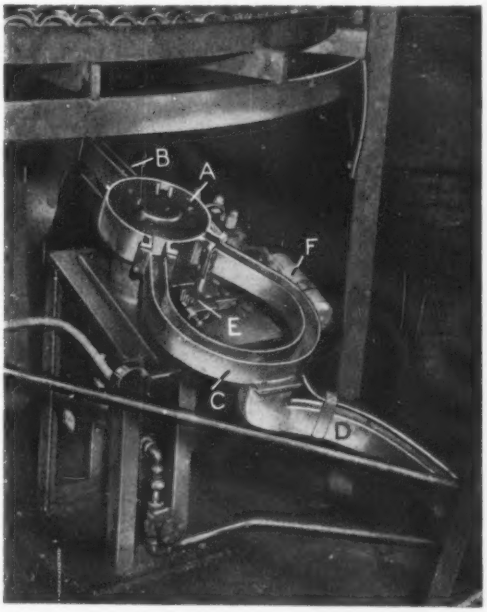


**Fig. 4. This Timken-designed Re-orientating Unit is Installed to Ensure that Cups are Delivered Alternately to the Finishing Line with Their Broad and Narrow Faces Leading**

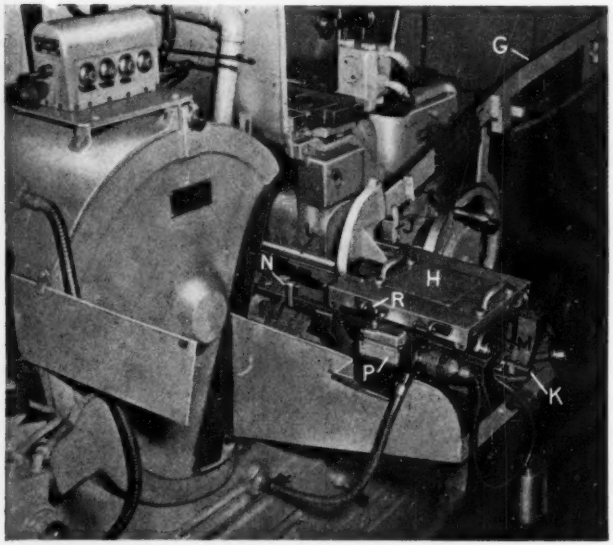


**Fig. 5. Feed Mechanisms of the Type Here Shown are Fitted to the Cincinnati No. 3 Centreless Grinding Machines for Cups, which are also Provided with Etamic Gauging Equipment**

As the pusher is withdrawn, a cup from the chute *G* passes downwards into the trough *L*, and occupies the space between the pusher and the end of the stack. When the pusher is again advanced, during the next oscillation cycle, it thrusts against the cup that has just been loaded, and the carriage is again moved outwards, so that another cup can drop into the trough, when the pusher is retracted. Cups are loaded during successive oscillatory cycles of the pusher, and the carriage is moved outwards until the switch *P* is re-set by the second striker screw *R*. The driving motor is then stopped, and the complete stack of cups is fed into the grinding throat of the machine as the carriage is urged forwards by the weight and cable system. When the carriage reaches the limit of its forward travel, the switch *P* is again re-set, and a further loading cycle is initiated.

## GAUGING EQUIPMENT FOR CUPS

From each of the Cincinnati machines (*U*, Fig. 1 and 3), rough-ground cups pass, by way of a chute, into a single-deck spiral brush feeder, and are delivered to a second Cincinnati No. 3 centreless machine, for finish grinding. Both the finish-grinding machines are equipped with automatic loading arrangements of the type just described, and all the Cincinnati machines are fitted with Etamic gauging and size-control units. At present, the Etamic equipment on three of the machines provides a visual indication of work-size during grinding by means of coloured signal lamps. One of the roughing machines has been equipped with feed-back control for automatic adjustment of the grinding wheel, because of the higher rate of wheel-wear which occurs at this stage. Eventually, however, all four machines will be thus equipped.

A quality control check is carried out after finish grinding, and one cup is removed every 30 min. from the outlet chute of the second machine of each line. Checking is carried out with the aid of the bench-mounted equipment shown in Fig. 6, which is located between the second Cincinnati machine, and the first of a battery of Heald 190 Centrimatic internal grinders. The outside diameter of each cup is measured by means of the adjustable gauge

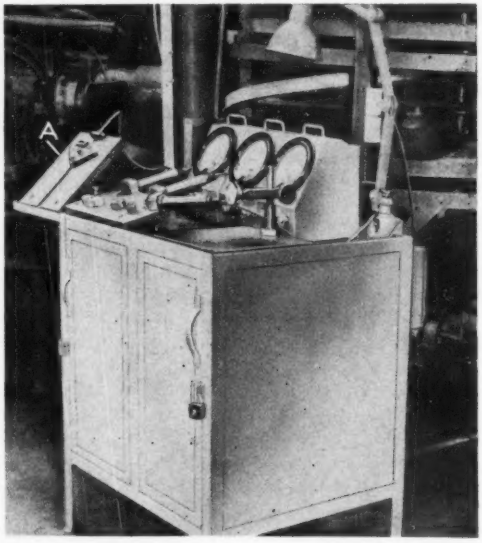


**Fig. 6. This Bench-mounted Equipment is Installed for Carrying Out Periodical Checks on Cups, for Size, Lobing, Tri-lobe Form, and Taper**

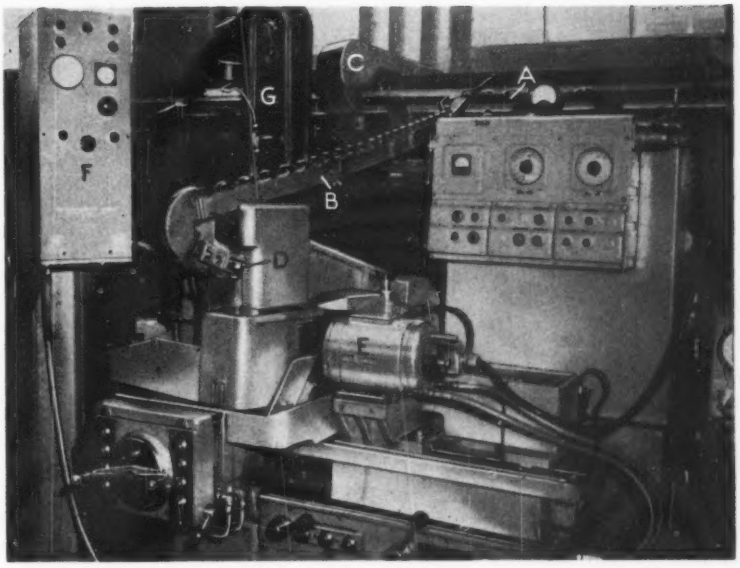


**Fig. 7. The Bores of Cups are Finish-ground on a Battery of Heald 180 and 190 Centrimatic Machines. This 190 Machine has Federal Automatic Size Control Equipment**

*A*. Lower and side supports can be set to position the cup beneath a gauging jet, which is connected to a Solex manometer unit at the rear of the bench. The gauge *A* is supported on a bracket at the left-hand side of the bench, and on the bench itself is mounted a 2-station gauge, and the associated Taylor-Hobson dial-type indicating units. A check for "lobing" is carried out at the left-hand station, while the work is rotated between a V-support and a stylus-type gauging head, which is connected to one of the indicators. Two stylus heads are employed at the next station to ascertain whether the cup has a "tri-lobed" form. The cup is finally checked for external taper by the sensitive dial-indicator gauge at the right of the bench.

Cups are delivered by chute from each of the Cincinnati finish-grinding machines to a 4-deck, spiral brush-feeder, and thence to a turn-over unit, which serves the Heald and Timken machines for finishing the bores of the cups. From the feeder, the cups are delivered to an elevator, and thence to the band conveyor of a distributor unit at the rear of the bore-finishing machines. One of the distributors may be seen at *V* in Fig. 3, and both units are similarly indicated in Fig. 1. The conveyor band circulates continuously, and its upper run moves over angularly-disposed support plates, mounted about 6-ft. above floor level. The structure whereon the conveyor is mounted takes the form of a long, shallow cabinet, which houses the service mains for the line of bore-grinding machines. These service mains provide for the delivery and return of grinding coolant, and hydraulic fluid, from and to centralized sources, also the supply of compressed air, and electrical power of both normal and high frequency.

The service mains, including those housed in the distributor units for the cone-finishing lines, are connected by a main service trench below floor level, to the service block, adjacent to the New Building. In this block is installed the plant for clarifying and pumping coolant for the grinding machines, as has already been mentioned. All the machines for grinding and honing cups and cones, and for grinding the ribs on cones, are hydraulically operated, and a central pumping installation circulates oil at a pressure of 150 lb. per sq. in. The system incorporates a by-pass centrifuge for continuous purification of the oil, and a stand-by pump unit.

All bore grinders are equipped with high-frequency spindle heads, and the electrical supply for these heads is generated by four motor-alternator sets, two further sets being provided as reserves. Since the bore-sizes of the components produced on each line differ, it is necessary to run the spindles at different speeds. In consequence, each of the four alternators is arranged to provide power of a suitable frequency for a particular line. Any alternator can be disconnected from one line and re-connected to another, and the frequency adjusted, in a few minutes, should a breakdown of any set of supply equipment occur.

## WORK-DELIVERY ARRANGEMENTS FOR BORE GRINDERS

The distributor unit for one of the bore-grinding lines for cups may be seen at the rear in Fig. 7. Cups are carried on the band, and move in contact with a guide strip *A*, at its lower edge. At intervals

along the conveyor, above the moving band, there are deflectors, which direct the workpieces into chutes leading to the three Heald 190 Centrimatic machines employed for grinding the bores of the large cups. One of these machines may be seen in the foreground in Fig. 7, and the delivery chute is indicated at *B*. On the parallel line for small cups, it may be noted, Heald 180 Centrimatic machines are employed, with similar delivery arrangements.

When each chute leading to a Heald machine is full, the cups continue to move on the band until they reach a transverse chain conveyor *C*. Then, the cups pass through a gap in the lower guide strip, and are transferred by the chain conveyor to a second horizontally-disposed band, which moves in the opposite direction to the first, on top of the distributor unit. On this band, cups are carried to the head of the distributor, where they are deflected, through a gap in the guide strip at one side, on to the first conveyor, and are re-circulated. Work-flow on the conveyor bands, and delivery of cups to the distributor, are controlled by limit switches, and the stock of cups maintained in circulation is sufficient to allow for routine stoppages—for example, to allow for replacement of the grinding wheels.

The entry end of each chute leading to a Heald machine incorporates a re-orientating section, whereby the cups are turned through 90 deg., before they enter the main portion of the chute. Cups roll down the chute, past a freely-rotating toothed-wheel *D*, which serves to control the flow, and are released, one at a time, to a pair of carbide-tipped shoes located between the wheel head *E* and the backing plate fitted to the work-spindle of the machine. While the conical bore is being ground, the work is supported on the shoes, and is driven by the backing plate, with which it is held in contact. On most of the Heald machines, the arrangements for holding the work against the backing plate are generally similar to those described in MACHINERY, 89/463—24/8/56. The machine shown in Fig. 7, however, is provided with a magnetic backing plate, and the usual clamping ring is not required.

This machine—the last in the line for large cups—is equipped also with Federal equipment for the control of bore size. Control is effected by means of a fork-type gauge, which is in position in the bore of the cup while it is being ground, and is connected to the unit *F*. During each cycle of the machine, under the automatic control system, the grinding head is advanced at a rapid-approach rate, and the bore is then ground to a diameter that is 0·0004 in. below finished size. The head is then withdrawn, the grinding wheel is dressed automatically, compensation is made for the amount of wheel material that has been removed, and the head is again advanced into the bore, to grind the part to finished size. Finally, the head is withdrawn, and the cup is automatically ejected. At the top of the control unit *F* there are three signal lamps, which are illuminated to indicate the various stages of the cycle. A green lamp signifies that the preliminary grinding stage is in progress; an orange lamp, the dressing stage; and a red lamp, the finishing stage. During grinding, the amount of metal removed is indicated by means of a large dial gauge below the lamps. This Federal control equipment has been found particularly effective in connection with the grinding of cups for bearings which must have close assembly limits. These bearings are required for certain applications, for example, the differential assemblies of motor cars.

## GAUGING CUP BORES

At regular intervals, cups are checked for bore-size by patrol inspectors, and a gauging station is installed between the second and third Heald

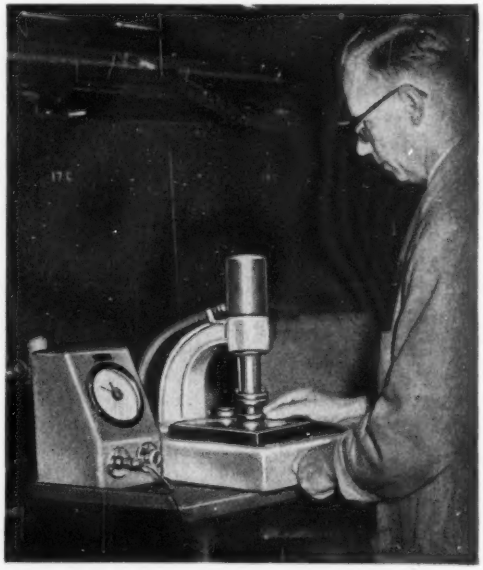

**Fig. 8. Periodically, the Tapered Bore of a Cup is Checked with this Equipment. The Bore Diameter is Indicated by the "Stand-up" of an Air Gauging Plunger, which is Registered on an Associated Mercer Dial-type Instrument**

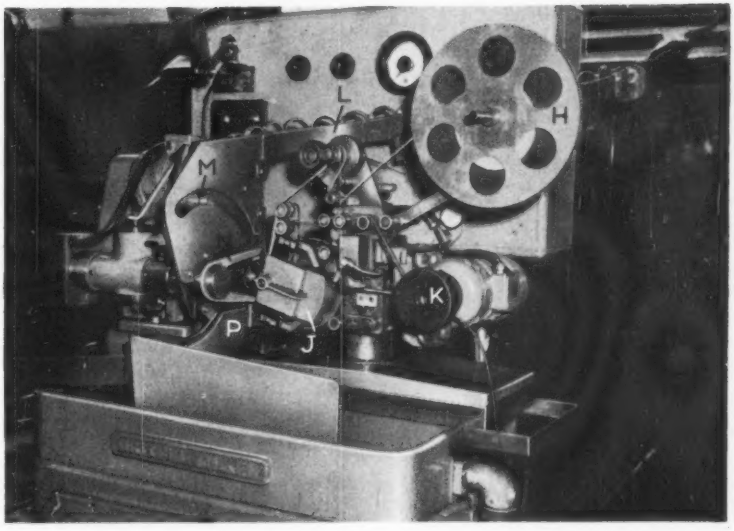


**Fig. 9. One of the Timken-designed Machines for Honing the Tapered Bores of Cups. Abrasive Tape is Employed as the Honing Medium, and is Held in Contact with the Work by an Oscillating Shoe**

machines of each line. A gauging station is shown in Fig. 8, and the equipment comprises an air-operated gauging plunger, and an associated Mercer dial-type instrument. The gauging plunger is mounted in a bracket, above a lapped surface plate on which the cup to be checked is placed. At the lower end of the plunger is secured a tapered adapter to suit the size of cup. By resetting a valve at the front of the gauging unit, the plunger is thrust downwards by air pressure, so that the adapter is engaged with the bore of the cup. The gap between the lower end of the adapter and the surface plate controls the flow of air from an associated jet, which is connected to the Mercer indicator. The arrangement is such that the diameter of the bore is indicated by the "stand up" of the adapter, which must lie between limits set by pointers on the dial of the instrument. Master cups are employed for setting the Mercer gauge, and a set of masters and adapters is provided for the complete range of cups produced.

From each of the Heald machines, large cups are delivered by chute to a belt conveyor, which is located between the machines of each group and the associated distributor. On the belt conveyor, cups are transferred to the elevator *G*, Fig. 7, from the top of which they roll, by way of a chute, to the second section of the angularly-disposed band conveyor of the distributor. From this second section, cups are deflected into the chutes of two machines (*W*, Fig. 1) on which the bores are honed. The arrangements of the second half of the distributor are generally similar to those that have already been described, and when the chutes are full, cups are transferred by a chain conveyor to the horizontal band conveyor, and are re-circulated.

## TIMKEN BORE-HONING MACHINES

The machines for honing the bores of the large cups were designed and developed by British Timken, Ltd., and a typical unit is shown in Fig. 9. Honing is effected by abrasive tape, which is drawn from a bulk-supply on the reel *H*. The tape passes, over guiding and tensioning rollers, to a honing shoe that projects from the head *J*, and thence, over further guide rollers, to a feed unit *K*. Pivotally mounted, the head *J* can be adjusted angularly in the vertical plane, with reference to a protractor scale, in order that the shoe may be set so as to support the tape in contact with the conical surface of the bore to be honed. Within the head, the shoe is supported on leaf springs, and can be oscillated rapidly, over a fixed stroke, parallel to the bore surface.

From the distributor at the rear, cups are fed down an inclined chute *L* to a loading unit mounted on the front of the workhead of the honing machine. The leading cup in the chute rests in the position indicated at *M*. In Fig. 9, the machine is shown with a workpiece loaded in position and the honing operation in progress. At the start of each cycle, a bifurcated lever *N* is swung downwards to carry the cup from the position at *M*, round an arcuate guideway, until it comes to rest on a pair of idler support rollers located in front of a rotating magnetic plate. Sufficient clearance is provided between the arms of the bifurcated lever to allow the workpiece, which is driven by the magnetic face plate, to

rotate freely on the supporting idler rollers.

With the cup rotating, the honing head is moved inwards, and then downwards, by hydraulic means, so that the abrasive tape is held against the cup-bore by the shoe. This shoe applies a pre-set pressure for a specific period, governed by a timer, during which the cup bore is rough-honed. At the end of this period, the head is lifted, hydraulically, to allow the abrasive tape to be advanced by the feed unit *K*, so that fresh tape is positioned around the shoe. Next, the head is again lowered, to apply the fresh abrasive tape to the bore for a further specified period, governed by a second timer, during which the bore is finish-honed.

At the end of the second, or finish-honing stage, the head *J* is lifted, and then retracted from the cup bore, fresh tape being advanced during this movement. At the end of this movement, the bifurcated lever *N* is swung upwards, and, at the same time, outwards. Next, the finish-honed cup is lifted by the lower arm of the lever, and, since it is no longer held against the back plate of the loading unit, it rolls sideways over the front supporting roller, through a gap in the arcuate guideway, and into the chute *P*. This chute leads to an elevator serving a 4-deck, spiral-brush feeder, and as the cup rolls downwards it passes through a de-magnetizing tunnel at the left-hand side of the honing machine. During honing, a mixture of 1 part of sulphurized honing oil and 9 parts of "300" burning oil is applied, to remove the fine particles of metal produced, and at this operation a finish of 4 to 8 micro-inches is obtained in the workpiece bores.

Honed cups are delivered from the brush feeder at the end of each cup line to a degreasing unit *X*, Fig. 1, where they are cleaned by high-pressure jets of distillate, which are directed on to them, from above and below, as they move on a twin-lane mesh belt. The distillate is continuously cleaned by means of a centrifuge. After they have been washed, the cups pass, by way of spiral-brush feeders and chutes, to a visual inspection station seen in Fig 10, where they are subjected to a 100 per cent check by two female inspectors. The cups roll down a chute *R* to a track in front of the first inspector, seen at the right. Of an S-form in plan, the track is built up from rods, and the open construction facilitates viewing. The track is arranged so that the cups are disposed at a slight angle, and their bores are readily visible to the inspectors. A mirror is mounted on the side of the track opposite to the inspector at each station, and enables the rear faces of the workpieces at each position to be viewed by reflection. Cups are rolled along the track by the first inspector, using a length of brass wire, and then pass by way of the inclined, middle section to the second station. Here, the face which was away from the inspector at the first position is presented towards the second inspector. Cups are checked for finish, presence of chamfers, marking defects and surface cracks. The thin coating of distillate left on the cups from the washing stage, it may be noted, emphasizes any cracks or flaws. At each station, the upper front-rail of the track is interrupted, and any faulty workpieces are deflected from the track by the inspectors, and fall into a chute below. The end of the second section of the inspection track communicates with a chute, whereby the cups are delivered to a greasing installation (*Y*, Fig. 1). Here, they travel on a moving belt through a bath of heated grease, which provides a protective coating, and, after draining, are delivered to a packing station (*Z*, Fig. 1) where they are fitted to pre-assembled cones, cages and rollers.

Automatic air gauging equipment is shortly to be installed, and one unit will be located at the end of each cup line, before the greasing installa-


**Fig. 10. Cups are Visually Inspected, on a 100 per cent Basis, at this Station, where they are Fed along Tracks, Past Operators who Inspect Each Side in Turn. Faulty Cups are Deflected from the Tracks into Chutes which Direct them into Bins**

tion. Each unit will be capable of measuring bore size, bore angle, cup width, and external diameter. Provision will be made on each unit for automatically rejecting those workpieces that are not within prescribed limits.

One group of work-people tend both cup lines. One setter and one operator, working on day shift only, serve the first two operation stages (Gardner and Cincinnati machines). The third and fourth operation stages (Heald and Timken machines) are run on three shifts, and are tended by one setter and one operator per shift. When the automatic gauging equipment is installed, final inspection will be carried out by two inspectors, who will work on day shift only.

## CONE RE-ORIENTATING UNIT

Like the cup-finishing section, the section for finishing cones is divided into two lines, and provides for processing two different sizes of cones, simultaneously. Hardened and tempered cones are fed by vibratory feeders and chutes from the hoppers *a*. Fig 1, to a Rowland duplex face-grinding machine *b*. This machine is provided with a dial-feed mechanism, also automatic sizing and control equipment. It may be of interest to note, moreover, that the wheel spindles of the Rowland machine, and of the Gardner machine for cups, are fitted with Timken tapered-roller bearings. The Rowland machine is operated for one 8-hour shift per day, and supplies both cone-finishing lines. Batches of cones of one size are ground at a time, and are stored in a spiral brush-feeder, or a hopper between the Rowland machine and the starting ends of the lines.

Cones are fed from the hoppers *a*, Fig. 1, with their large ends either to the right or left, and before cones enter the Rowland machine it is necessary that they should be arranged with their large ends on the same side of the delivery chute. A simple but effective, re-orientating unit is incorporated in the chute and is shown in Fig. 11, where the section of the chute leading from the hoppers is indicated at *A*. As may be seen, the chute has two branches, one of which is in line with the section *A*. The other branch, *B*, curves to the right (looking in the direction of cone travel). The curved portion of the branch *B* subtends an angle of about 160 deg., and the bottom plate of the chute terminates at the end of this portion, so that a cone can drop into the lower chute *C*. This latter chute follows an angular path, and is finally aligned with the entry chute *D* of the Rowland machine. The straight upper chute of the re-orientating unit is also aligned with the chute *D*, but is positioned above it, and the length of the bottom plate of the upper chute is such that a cone passing along it eventually drops into the chute *D* and thence to the Rowland machine.

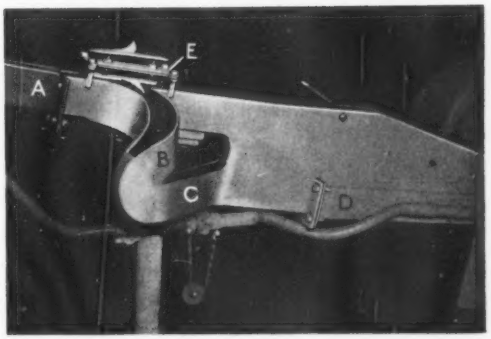


**Fig. 11. This Re-orientating " Point " is Installed in the Chute that Delivers Cones to a Rowland Duplex Face-grinding Machine, and Ensures that the Cones Enter the Machine with their Large Ends Facing in the Same Direction. This Unit can be Adjusted to Take Different Cones**

Mounted above the junction of the straight and curved chutes of the unit is a reversible plate *E*, to which are secured upper and lower guides. Each guide has one straight, and one curved, arm, and the arrangement is such that, when each is positioned below the plate *E*, there is a gap between the straight arm and the left-hand side of the chute (looking in the direction of cone travel), and between the curved arm and the right-hand side of the chute. If a cone rolls down the chute *A* with the rib at its large end to the left, the rib passes into the gap between the straight arm of the guide and the left-hand side of the chute. In consequence, the cone is directed down the straight, upper chute of the re-orientating unit, and drops into the chute *D*, with its larger end still at the left.

When a cone rolls down the chute *A* with its large end to the right, the rib at that end enters the gap between the curved arm of the guide and the side of the chute *B*. It is directed round the chute *B*, and drops, through the gap in the lower plate, into the chute *C*. During this movement, it has been turned through about 160 deg. relative to its original setting, and it enters the chute *D* with its large end to the left—that is, on the same side as for the cones delivered by the upper chute. The upper and lower guides on the plate *E* cater for cones of different diameters, and can readily be brought into use by releasing four nuts and reversing the plate.

## MAGNETIC ELEVATOR

From the re-orientating unit, cones pass down a curved chute, and enter semi-circular seatings in the feed-dial of the Rowland machine, one at a time. The dial rotates in the vertical plane, and is positioned between the grinding wheels. Cups are carried round on the dial, to pass between the wheels, and after they have been ground, drop into a chute that leads to a vertical elevator. This elevator differs from the others in the N.B. plant, since it is not of the standardized chain-and-peg design, but is of a recently-developed magnetic type. A close-up view of the upper end of the elevator is given in Fig. 12, and it will be seen that it incorporates a moving belt *F*, of plastics-reinforced fabric. This belt passes over pulleys at the upper and lower ends of the supporting framework, which is constructed from steel sections. The upper pulley is driven by a motor, with an integral reduction gearbox, and the run of the belt seen in Fig. 12 moves upwards over a continuous series of permanent magnets, mounted between the side-members of the supporting frame.

The chute from the Rowland machine terminates in front of the belt, at the lower end of the elevator,

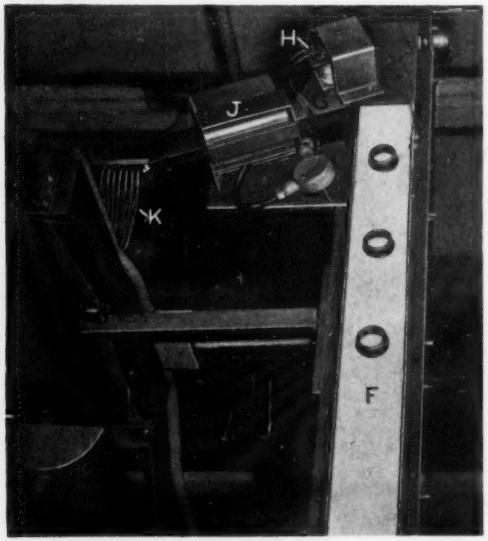


**Fig. 12. The Elevator on the Outlet Side of the Rowland Machine Differs from the Others in the N.B. Plant, and Incorporates Banks of Magnets for Holding the Cones on an Upwardly-moving Belt**

and cones are attracted to, and held on, the belt by magnetic force. Carried upwards on the belt, the cones enter a casing which surrounds the belt at the upper end of the elevator, and are thrust sideways by a deflector blade, towards the chute *G*. A heavy-duty electro-magnet *H* is mounted on the outside of the casing, and serves finally to pull the cones from the belt, and into the chute. Once a cone is clear of the belt, is passes down the chute, through the de-magnetizing tunnel *J*, and into the standard Timken re-orientating cage *K*. As it drops through this cage, it is turned through 90 deg., and subsequently enters either of the two chutes that connect the elevator to the storage units for the two cone-finishing lines.

A general view of one of the two parallel cone-finishing lines is given in Fig. 13, and the magnetic elevator may be seen in the foreground, with the two delivery chutes extending to either side. Cones are directed into each chute as required by a simple pivoted deflector. It may be noted that the arrangements for feeding workpieces to the machines in each line are generally similar to those that have been described in connection with the finishing of cups. A distributor unit, incorporating angularly-disposed and horizontal band conveyors, is located at the rear of the machines in each line, and cones are deflected from the angularly-disposed conveyor into the delivery chute of each machine. If the chutes of a group of machines are full, cones are transferred by transverse chain conveyors to the horizontal band, which moves in the opposite direction to the angularly-disposed band. On the horizontal band, workpieces are returned to the head of the group, and are there deflected back on to the first band, for re-circulation.

## DRUM FEED UNIT

The 4-deck spiral brush-feeder that serves one cone-finishing line may be seen at the extreme left in Fig. 13, and is indicated at *c*, in Fig. 1. Since the plant was originally laid down, it has been found that cones with narrow ribs tend to lock in the spiral tracks of such feeders, and a different type of storage unit (*d*, Fig. 1) has been installed for the other finishing line. This storage unit is shown in Fig. 14, and the chute whereby cones are delivered from the magnetic elevator is indicated at *L*.

Cones fall into the bulk storage hopper *M*, which is provided to avoid an excessive load on the rotating drum feeder *N*. A Riley Stoker vibrator unit is fitted to the hopper to facilitate delivery of the cones to the feeder *N*, and is controlled by means of the Syntron unit mounted at the side of the hopper support frame. Cones pass, one at a time,

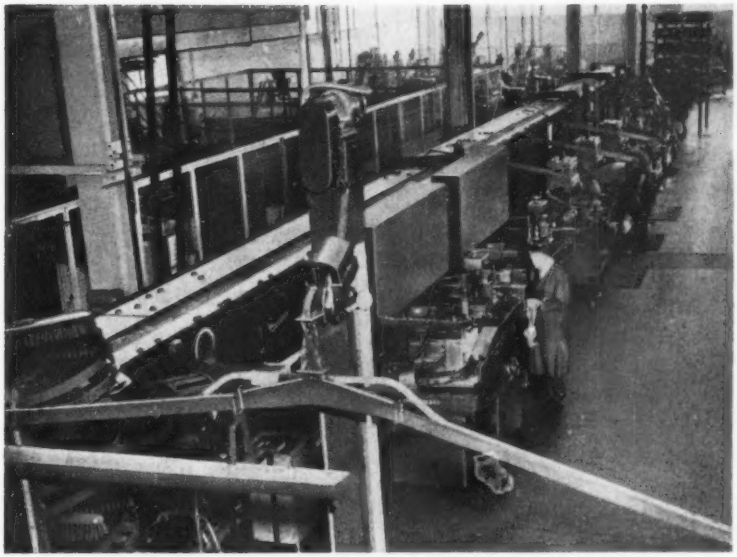

**Fig. 13. A General View of One of the Two Parallel Cone-finishing Lines. Work is Delivered Automatically to each Machine by Distributor Conveyors at the Rear of the Line**

into seatings in the feed drum, which is driven by an f.h.p. motor, through a reduction gearbox. As the drum rotates, the cones are transferred to the chute *P*, down which they roll to the pick-up position at the lower end of the elevator *R*. This elevator is of the standard Timken chain-and-peg design, and the cones, carried upwards on the pegs, are deflected into the chute *S*. As they pass down this chute, the cones are turned through 90 deg., and are delivered to the angularly-disposed band of the distributor unit, at the left, with their large ends downwards.

The guide strip at the lower edge of the conveyor band (with which the cones make contact as they travel along the distributor) incorporates a hinged section, just visible at *T* in Fig. 14. Normally, this section is maintained in line with the remainder of the strip by a counterweight, but if the number of cones that are circulating on the distributor is excessive, their weight deflects the strip, and an associated limit switch is actuated. This switch is connected to the driving motors for the elevator and disc feeder, which are then stopped, so that feeding of the cones ceases. When the number of cones on the band conveyor has been reduced, the hinged section resumes its normal setting, and feeding is resumed.

## CONE-FINISHING LINES

Similar operations are performed on each cone-finishing line. Cones are delivered first to one of two Cincinnati No. 1 Microcentric race-grinding machines in each line, on which the conical roller track and the face of the small rib is finished. Each cone is fed from an upper chute on to two work-supports in front of an electro-magnetic driver plate on the work-spindle of the machine. At the

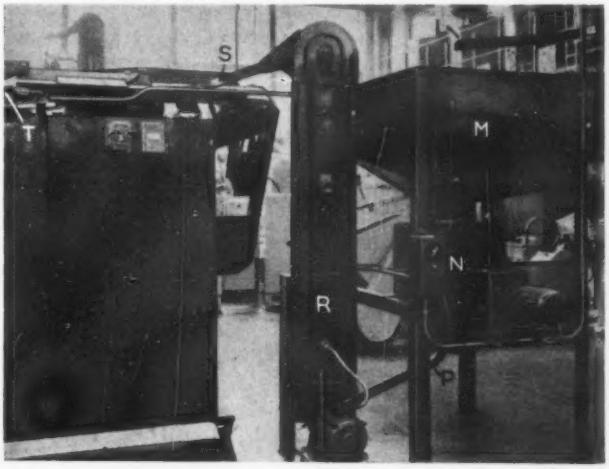


**Fig. 14. To Avoid Interlocking of Certain Sizes of Cones, This Hopper and Drum Feeder are Employed for the Storage and Delivery of Cones at the Head of One Finishing Line, in Place of the Usual Spiral Brush Feeder**

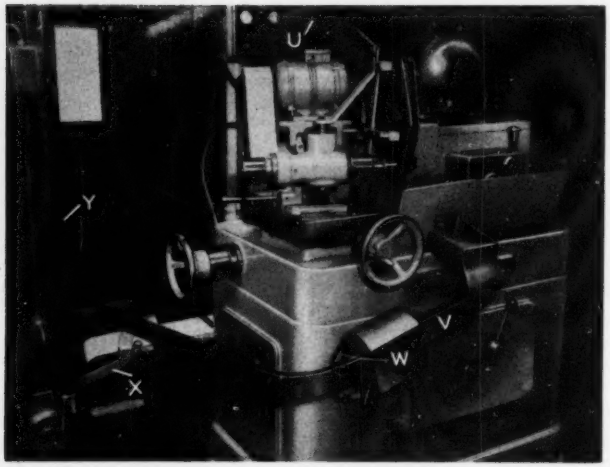


**Fig. 15. One of the Timken-designed Automatic Grinding Machines for Finishing the Ribs at the Large Ends of Cones. Each Cone is Held on a Magnetic Face-plate on the Work-spindle, and, after it has been Ground, Passes Through a De-magnetizing Tunnel in the Outlet Chute**

end of the grinding cycle, the cone is deflected into a lower chute, which passes through a de-magnetizing tunnel. By way of this chute, cones are directed to a band conveyor at the rear of the Cincinnati machines, and are delivered to a chain-and-peg elevator, which returns them to the angularly-disposed band conveyor of the distributor unit. Each Cincinnati machine is fitted with automatic control equipment, whereby the abrasive wheel is dressed after 7 to 10 cones have been ground.

The cones pass along the second section of the distributor band, and are deflected into chutes serving three Heald 190 Centrimatic machines for grinding the bores. These chutes differ from the conventional U-section type associated with the Cincinnati machines, and each consists of a side-plate with upper and lower L-shaped strips which embrace the rib at the large end of each cone. Consequently, the cones are fed towards the Heald machines with their large ends in contact with the chute side-plate, and their small ends extending outwards. The Heald machines are fitted with Sizematic gauging equipment, whereby the bore of each cone is checked automatically by means of a plug gauge, and the grinding wheel is dressed during each cycle.

From the Heald machines, the cones are passed back to the distributor, whence they are fed by chute to either of the rib-grinding machines. These machines were designed by British Timken, Ltd., and the second machine of the right-hand line (as viewed in the direction of work flow) is shown in Fig. 15. The delivery chute for cones is indicated at *U*, and the workpieces roll down to a transfer unit mounted on the work-head of the machine. This transfer unit is somewhat similar to that fitted to the Timken machine for honing cups. In this instance, however, there is a swinging lever with a plug which enters the bore of the cone at the pick-up position. The arm is then swung downwards, by the action of a hydraulic cylinder, to position the cone in front of the magnetic face-plate on the work-spindle, where it is supported on a pair of rollers.

The wheel-head of the machine, seen at the right in Fig. 15, is fed inwards towards the workpiece by means of a vertically-moving wedge, coupled to the piston rod of a hydraulic cylinder. Initially, the wheel-head is fed inwards at a fast rate until the wheel makes contact with the rib of the cone. Then, as the load on the driving motor increases, the rate of infeed is automatically reduced to that required for the grinding operation proper. When the grinding has been completed, the wheel is rapidly withdrawn, after a predetermined spark-out period. Next, the transfer arm is moved outwards, and upwards, to pick up the next cone, and the workpiece that has just been ground is thrust into a chute below the work-support rollers.

This chute is bent through an angle of 90 deg., and the bottom member is cut away at the end of the curved portion, so that the cone can fall into the chute *V* below. By this arrangement, the cone, which was held on the magnetic face-plate with its small-end outwards, passes down the chute *V* with its small-end inwards. As it rolls down the chute, it passes through a de-magnetizing tunnel *W*, and thence to a helical portion at the lower end of the chute, whereby it is turned through 90 deg. before it is delivered to the band conveyor at the rear of the machine, with its large-end downwards. From the band conveyor, cones are deflected into a chute *X*, which leads to the loading position at the bottom of the elevator *Y*. This unit is of the chain-and-peg type, but, in this instance, the pegs are arranged at 90 deg. to the chain pivot pins. The cones are carried upwards and are delivered to a 4-deck, spiral brush-feeder, at the end of the line, as indicated at *e* in Fig. 1.

At pre-set intervals, the angle between the rib and the track of a cone is checked by means of an optical projector, and Mercer air gauging equipment is provided for an occasional check of the diameter of the cone bores. Machines, similar to those used for cups, have been designed and developed by British Timken, Ltd., for honing the roller tracks of the cones after the ribs have been ground. These machines are now being built, and should be installed before the end of the year.

From the spiral brush feeder at the end of each finishing line, cones are delivered to a cleaning unit, where they are carried on a belt through jets of distillate. After they have been cleaned, cones are subjected to a 100 per cent visual inspection, similar to that for the cups. Automatic air gauging equipment will shortly be installed, and will provide for measuring the diameter of the bore, the diameter of the roller track, the angle of the roller track, the overall width, and the thickness of the rib on each cone.

After the final inspection stage, the cones from each line are graded for track diameter, using equipment that incorporates a precision indicator gauge, with the dial divided into coloured segments. After being graded, the cones are delivered, in batches of one grade, to a semi-automatic machine, where the rollers and cages are assembled to them, to form complete inner races. Rollers, also graded and batched, are delivered from an adjacent section, which will be considered later, and cages are supplied, as finished products, from the press shop of the main factory.

The assembly machines are similar to those used in the main plant, and have been described in MACHINERY, 91/420—23/8/57. Rollers are delivered in batches of different grades, and a grade is selected to suit the batch of cones that is being handled. Inner-race assemblies are passed through a washing unit, and are finally coated with protective grease, by immersion.

As in the cup-finishing section, one group of work-people tend both cone-finishing lines. Face grinding (Rowland machine) and assembly are carried out for one shift per day, and the remaining operations for three shifts. One setter and one operator per shift are responsible for the Rowland and Cincinnati machines, and two setters and two operators per shift tend the Heald and Timken machines. One operator is required for each of the assembly machines.

## ROLLER-FINISHING SECTION

At present, two different types of rollers are required for the bearings produced in the N.B. Plant, and they are finished on two parallel lines, one of which is indicated at *f* in Fig. 1. Work flows continuously along the lines, which are equipped with similar machines. The equipment provides for the production of rollers, of each main type, in a number of different grades, or size groups. The size-difference between grades is 0·00025 in. (on body diameter), and rollers are later sorted into half-grades, which differ by 0·000125 in. Rollers are delivered, in bulk, to the finishing section from the main factory, where the earlier operations in the production sequence are performed. These operations include heading, barrelling and hardening, and are carried out on a batch-production

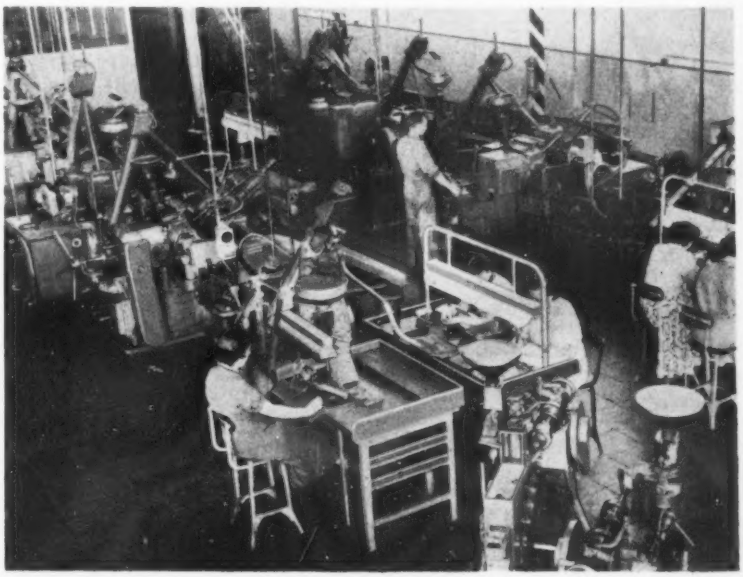

**Fig. 16. General View of the Roller-finishing Section of the N.B. Plant. There are Two Parallel Lines Comprising Centreless Grinding, and Spherical-end Grinding Machines, Connected by Rotating-spiral Conveyors**

basis, using conventional machines and equipment.

A general view of the roller finishing department is given in Fig. 16, looking from the left-hand end of the lines (as viewed in Fig. 1). Operations start at the opposite end, and, on each line, the first stage consists of rough-grinding the bodies of the rollers on a standard Cincinnati No. 2 centreless machine, equipped with a hopper feed mechanism and a spiral control drum. From 0·008 to 0·010 in. (on diameter) of metal is removed at this stage. From the outlet side of the first machine, the rollers are fed, by chute, to an angularly-disposed, rotating-spiral conveyor, whereby they are delivered to the hopper of a second Cincinnati machine. This machine has equipment similar to that of the first, and provides for semi-finishing the rollers, from 0·004 to 0·005 in. (on diameter) of metal being removed. Next, the rollers are fed by way of a spiral conveyor to a machine on which their large ends are ground to a spherical form. On this machine, which was built in this country to American Timken design, the rollers are carried between spring-loaded rotating plates, whereby their large ends are presented to a cup grinding wheel. Finally, the body of each roller is finish-ground on a Cincinnati No. 2 machine, with similar equipment to that provided for the first two stages, and 0·002 in. (on diameter) of metal is removed. From the last Cincinnati machine, rollers are passed through a washing unit, and are then dried by feeding them through a spiral conveyor, which is electrically heated. From this conveyor, rollers are delivered to the hopper unit of a mechanized inspection station, where they are subjected to a visual check.

## MECHANIZED VISUAL INSPECTION

A close-up view of the inspection station is given in Fig. 17. The operator is seated in front of a bench, whereon is mounted a work-support, which incorporates a power-driven inner drum. This drum is rotated in an anti-clockwise direction, through a worm and wheel, and is surrounded by a cage, which is free to rotate. A layshaft is pivoted below the drum, and is driven by a belt from the drum-shaft. This layshaft carries a friction disc, which engages a similar disc mounted on the cage, and drive can thus be transmitted from the drum shaft, through the layshaft, to the cage, the latter then rotating in a clockwise direction. Rotation of the cage can be started and stopped by tilting the layshaft, and a lever is provided, which forms an extension of the shaft, and is controlled by the operator's left hand.

Rollers are fed, from the hopper above the bench, through an escapement mechanism, which

**Fig. 17. Rollers are Visually Inspected on a 100 per cent Basis at this Bench Station, which is Provided with Equipment for Rotating the Rollers Continuously and Indexing Each in Turn to the Viewing Position**

is actuated by a vertical shaft, oscillated from the drum-driving mechanism. The rollers are delivered, one at a time, down a tube to the left-hand side of the unit, where they enter one of the slots in the cage. The drum and cage are of conical form, and the roller rests in the cage with its small end in contact with the lower end of the slot. Due to the motion of the drum, the roller is continuously rotated at a slow speed, and, by engaging the cage drive, it can be brought to a position under a magnifying lens, which is adjustably mounted on an pillar at one side. The cage-drive is then disengaged, so that the roller rotates slowly in the viewing position. Inspection is facilitated by the bright illumination provided by an overhead fluorescent lamp, and a mirror is adjustably mounted at the rear of the drum, in order that the large end of the roller may be viewed.

When the inspector has satisfied herself that the roller is satisfactory—or has removed it from the cage and placed it in one or other of two bins at the right of the bench if it is faulty—she engages the drive to the cage, to bring the next roller into the viewing position. Rollers that have passed inspection are carried in a clockwise direction, by successive movements of the cage, and when they reach the "3-o'clock" position, fall into a chute at

the right, and thence into a work-pan below the bench.

After visual inspection, rollers are passed, in batches, to one or other of the two Timken-designed grading machines at the end of each line, as seen in the right foreground in Fig. 17. These machines, which are hopper-fed and automatic in operation, are similar to those described in MACHINERY, 91/422—23/8/57. The machines segregate the rollers into over- and under-size grades, also into nine intermediate diameter groups, which differ by 0·000125 in. In practice, however, in order to facilitate assembly, rollers are finished-ground to an accuracy such that their diameters rarely lie outside the middle three or four grades. Finally, the graded rollers are washed, stored, and withdrawn, as needed, to meet assembly requirements.

## PACKAGING

Assembled inner races—each comprising a cone, cage, and set of rollers—are matched to cups at the packaging station at the end of the cup-finishing line. Complete bearings, or separate matched cups and inner race assemblies, are packed into cylindrical cartons. At present, this work is performed manually, as are the final capping and stamping of the cartons. A packing machine is now in the final stages of development, however, and will be capable of inserting bearings in cartons at a rate of 42 per min. Four of these machines will eventually be installed.

## FUTURE DEVELOPMENT

British Timken, Ltd., do not consider that the N.B. plant can ever be regarded as complete, since there are continual developments, whereby old problems can be solved, or improvements can be made. Already, many of the outstanding problems associated with the automatic production of bearings have been solved technically, and the introduction of the necessary new equipment depends solely upon sufficient standardization by bearing users to make such equipment economically justifiable. It is not considered that the degree of mechanization and automatic control in the British plant will approach that in the comparable plant of the American Timken company, since there is less standardization of bearing sizes here than in the U.S.A., British wage rates are lower, and certain machines and items of equipment, which can only be purchased from America, would involve the expenditure of dollars.

Apart from obvious benefits to consumer and manufacturer, which arise from reduced production costs, the N.B. project has many other advantages. Working conditions in the automatic plant are excellent, and the building is clean, light, and air-conditioned. The accident rate has been reduced to a remarkably low level, since the operators' hands need only be in contact with the mechanisms of the machines during tool change-overs, and manual loading has been completely eliminated. With the introduction of mechanized loading for furnaces and quenching presses, the discomforts associated with working close to heat sources, and in oil fumes, have been minimized, and, in general, all heavy manual work has been eliminated.

It was planned, initially, that as factory employees became more experienced in the working of the lines, and the lines themselves became more stabilized, both operators and supervisors would be circulated from one section to another. This system is now in operation, and not only provides a broad supervisory experience, but also helps to eliminate any boredom among operators, who might otherwise continually be performing repetitive tasks. In these various ways, British Timken are trying to create a factory that is technologically and economically worthwhile, and provides working conditions of the best modern standards.

In the future, the company plan to apply the results of technological developments to the N.B. plant as they become available and economically justifiable. It has already been mentioned, for instance, that it is intended to incorporate automatic final-gauging and inspection machines for some bearing sizes, in the near future. Moreover, the techniques practised, partially or completely, in this factory will be installed elsewhere in the Timken factories, if they are considered suitable. Thus, the experience gained will be applied to the design and construction of similar production lines, whenever the volume of production permits. In this connection, it should be mentioned that the company has recently designed and started to build, a new factory at Daventry, of approximately the same area as the N.B. plant. This new factory will have automatic production lines for the manufacture of those larger Timken tapered roller bearings associated with railway applications, and is planned to be in full production next year.

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THE PRODUCTION OF PORTABLE POWER TOOLS in the first quarter of 1957 reached a total value of £4,203,000, of which £1,587,000 was for export. In the second quarter of the year, tools to the value of £4,116,000 were produced, and exports totalled £1,533,000. For comparison, it may be noted that the values for production in the first and second quarters of 1956 were £2,700,000 and £4,164,000, respectively.

# The Re-servicing of Carbide Tools

The economic advantages of tungsten carbide tooling can be fully realized only by careful attention to the correct methods of servicing employed at the correct times. In this article, based on material supplied by Wickman, Ltd., are discussed both grinding by conventional methods, and the recently developed spark-erosion process for servicing carbide tools. It includes some recommendations which may prove helpful to those who want to get the best from carbide tooling.

## TUNGSTEN CARBIDE STRUCTURE

Tungsten carbide has a granular structure, and, for this reason, the individual grains are liable to chip or flake-off, if pressure or shock is applied when the material is not adequately supported. It is important to bear this fact in mind in connection with the re-servicing of carbide tools, and, when grinding, it must be ensured that the wheel rotates into the tool, as indicated in Fig. 1, and not away from it. Unless this precaution is taken, the grains of carbide on the edge of the tool are unsupported, and may flake-off, leaving irregularities which will result in poor performance.

A tool which has been ground on the periphery of a wheel will have a concave front clearance, and the effective support for the edge will, therefore, be reduced. Then, under cutting pressure, early deterioration of the edge is likely to occur, as will be evident from Fig. 2. Similarly, too much front clearance is liable to result in breakdown of the cutting edge. For general work, a front clearance of between 4 and 5 deg. has been found satisfactory and will provide adequate support for the edge of the tungsten carbide tip.

## GRINDING WHEELS

To ensure efficient re-servicing of carbide tools, it is important that the grinding wheel is of the correct type and grade.

For this purpose, wheels incorporating the following abrasives are employed: silicon carbide, aluminium oxide, and diamond. Grinding wheels have also been made from boron carbide, but, at the present stage of development, this material does not appear to be satisfactory for stock removal, and is more suitable for burnishing operations.

As a matter of interest, it may be noted that silicon carbide and boron carbide are of approximately the same hardness, whereas diamond is nearly four times as hard, and, for this reason, is much more effective than the other abrasives mentioned. On the other hand, it is expensive.

Grinding wheels are made from grains of uniform size, and, in general, the coarser grains ensure more rapid stock removal. However, rapid cutting is achieved at the expense of surface finish, and several successive grinding operations are often performed with wheels of progressively smaller grain size. For polishing, grain sizes of the order of 300 to 400 mesh are commonly employed.

The properties of the bond material, which holds the abrasive grains, have an important influence on the performance of the grinding wheel. It will be apparent that the harder the bond, the more securely will the individual grains be retained. After an abrasive grain has been in operation for some time, the cutting edge becomes dull, and the forces tending to pull the grain

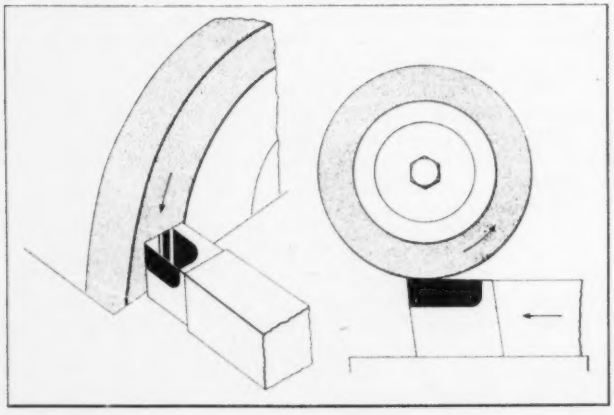


**Fig. 1. When Grinding Tungsten Carbide, the Wheel Should Rotate "Into" the Tool, as Here Shown, and not Away from it**

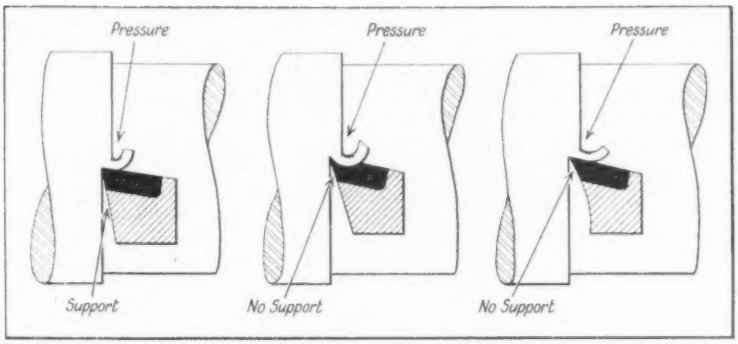



**Fig. 2. Unless the Carbide Tip is Adequately Supported, the Cutting Edge will Rapidly Deteriorate. (left) Tool with Adequately Supported Tip. (centre) Tool with Too Much Front Clearance. (right) Tool Ground on Periphery of Wheel**

out of the bond are then increased. In wheels with a soft bond, the abrasive particles are pulled out when the cutting efficiency has deteriorated only slightly. A soft-bond wheel, therefore, always cuts with sharp edges, so that rapid stock removal can be expected. For the same reason, the life of a soft-bond wheel is relatively short.

A soft-bond wheel, moreover, is much more susceptible to accidental damage and grooving, and such wheels are more suitable for machine grinding operations, where cutting pressures are controlled, than for off-hand grinding.

It is the usual practice to employ metal-bonded wheels for the latter purpose, because they are much less likely to be damaged if an operator inadvertently "digs in" the point of a tool. Because these wheels retain the abrasive grits until they have lost much of their efficiency, cutting tends to be slow, but the "life" is greater than for soft-bond wheels.

So long as the edge of the abrasive grains remain sharp, they will cut without inducing excessive heat in the work. Tungsten carbide is, however, so hard that the edges of the abrasive particles are dulled fairly rapidly, and, unless the wheel is re-dressed at frequent intervals, undue heating will occur and hair-line cracks may develop in the tip. Such overheating is more liable to occur if the bond is too hard, and the cutting surface of a wheel which has become glazed, as the result of grinding tungsten carbide, is seen on the left in Fig. 3. A wheel in this condition requires to be re-dressed to expose new and sharp abrasive particles. In contrast, the surface of a wheel in good condition is seen on the right.

## DIAMOND WHEELS

The extreme hardness of diamond makes it particularly suitable for grinding tungsten carbide, and diamond particles, held by a suitable bonding material, are made into various forms of wheels for this purpose. Diamond is expensive, and for this reason the grinding wheels are made up in such a manner that the diamond particles are concentrated in a rim or layer, and are not distributed throughout the body, as in silicon carbide or aluminium oxide wheels.

Grit sizes are chosen in the same manner as for ordinary grinding wheels, and the following are representative of those employed in the manufacture of diamond wheels suitable for re-servicing carbide tools:—

| | |
|---|---|
| Coarse | 85/100 (fast stock removal) |
| Medium | 120/240 |
| Fine | 140/300 |
| Superfine | 400 (slow cutting, but good surface finish) |

Diamond wheels are available commercially with bonds of different hardness. For the softest types of wheels, synthetic resins are employed, and for the harder types, metals such as bronze, cast iron, or steel. Resin-bonded diamond wheels are

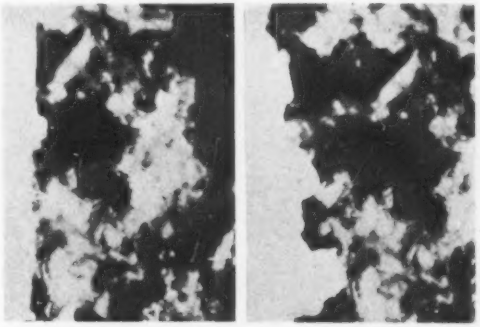


**Fig. 3. Photomicrographs of a Wheel Surface with Dulled Cutting Edges (left) and in Good Condition (right)**

generally recommended for machine grinding, and metal-bonded wheels for off-hand grinding. Some users, however, employ resin wheels for off-hand work, on account of their rapid cutting and good surface-finishing properties, and rely upon well-trained and experienced operators to avoid accidental damage.

A further characteristic of diamond wheels is concentration, which indicates the weight of diamond contained in a unit volume of the abrasive rim. Concentration is usually designated as follows:—high or 100, normal or 50, and low or 25.

Concentration of a diamond wheel is also related to the number of cutting points. High concentration wheels, with the greatest number of cutting points, therefore, obtain faster cutting than those of low or normal concentration.

### OFF-HAND GRINDING

In off-hand grinding, the operator holds the tool against the wheel with manual pressure, and, normally, moves it so that the face to be ground is passed to and fro across the wheel surface. Off-hand grinding machines are available, however, on which the wheel oscillates relative to the work-table. With this type of machine, it is claimed, the full width of the diamond wheel face is employed, so that long life is ensured, and less operator skill is required, since the tool has only to be pressed on to the table and pushed against the wheel. A prototype Neven GF2 Mark V machine, with an oscillating wheel-head, is shown in Fig. 4.

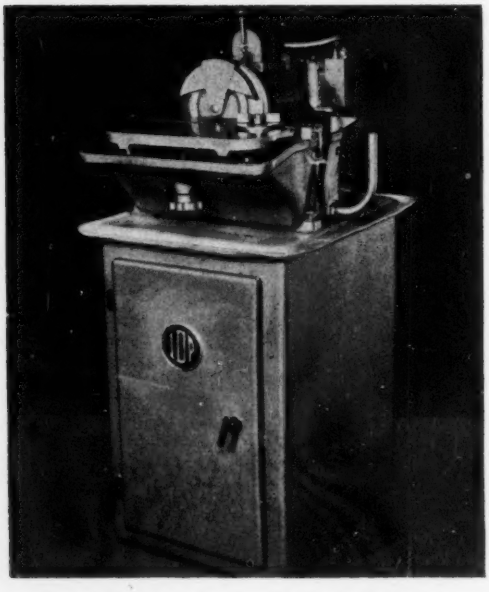


**Fig. 4. Prototype Neven GF2 Mark V Grinding Machine, with Oscillating Wheel-head, for Carbide Tools**

Off-hand grinding is widely used for tool reconditioning in the engineering industry, and is suitable for many types of tools where extreme accuracy is not required. Many machines are available which have been specially designed for this form of grinding, and an adjustable worktable is usually provided, which can be set and locked at the required angles for grinding the faces of the tool. There is also an adjustment whereby the table can be advanced towards the face of the wheel to compensate for wear.

It is important that the spindle of an off-hand grinding machine should be of generous dimensions, and free from vibration, run-out, or end play. If these defects are present, uneven wear of the grinding wheel is inevitable. There may be provision for reversing the direction of rotation, so that both right- and left-hand tools can be processed on the same wheel.

Normally, a copious flow of coolant is directed over the tool and wheel during grinding, so as to prevent over-heating, and off-hand grinding machines, a typical example of which is shown in Fig. 5, normally are equipped with coolant tanks and pumps to ensure an adequate delivery. An intermittent supply of coolant is extremely undesirable, as the alternative heating and cooling of the tool tip is likely to result in cracking. It is preferable to grind dry than with an insufficient or interrupted flow of coolant.

To obtain optimum performance, and to ensure maximum economy in re-servicing operations, a carbide tool should be sharpened when the wear land on the tip reaches a width of 0·015 to 0·020 in. It may, of course, be necessary to re-service a tool before this amount of wear has occurred if it has become chipped or cratered.

Provided that a tool is withdrawn from service before excessive wear has taken place, cracking of the carbide can generally be avoided, and the cutting edge can be restored by using a "green grit" silicon carbide wheel of medium/hard bond, or, alternatively, a metal-bonded diamond wheel.

In cases where, because of the presence of cracks in the carbide tip, there is a considerable amount of material to be removed before the tool can be put back into service, a soft "green grit" wheel is used for removing the bulk of the material, and the tool is finished with a silicon carbide wheel of harder grade, or with a diamond wheel.

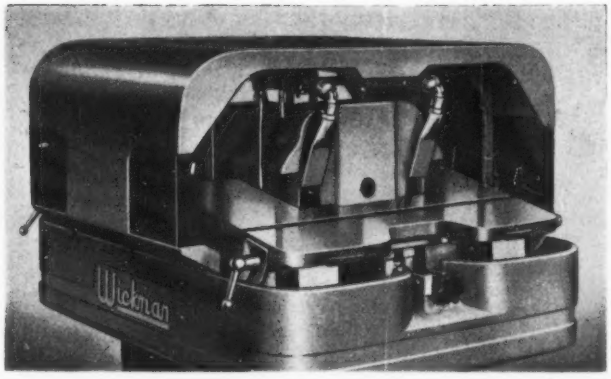



Fig. 5. A Typical Off-hand Grinding Machine for Carbide Tools

During off-hand grinding, the tool should not be pressed too hard against the wheel, as this may cause overheating, with the attendant danger of crack formation in the carbide tip. To avoid any tendency for the wheel to become grooved, the tool should be passed right across the face.

## SEQUENCE OF OPERATIONS FOR OFF-HAND GRINDING

Rough Grinding. For the purpose of explanation, the complete sequence of operations, from preliminary rough grinding to final lapping, will be described.

At the preliminary rough-grinding stage, the required cutting rake, on the top surface of the tip, is rough ground. Normally, this operation should be avoided in re-servicing, in order to preserve the overall depth of the tool. Chipped or broken cutting edges are usually cleaned up during the rough grinding of the side and front clearances.

Next, the secondary front and side angles on the steel shank are ground with an aluminium oxide wheel. These angles should be 2 to 4 deg. greater than the clearance angles required on the tip, to ensure that the shank does not contact the silicon carbide wheel subsequently employed for grinding the tip. Thus, if the tool is to be ground to give a 4 deg. primary clearance, the machine should be set at 6 to 8 deg. for grinding the secondary clearance.

The front clearance on the tip now is ground, using a soft-bond silicon carbide wheel, and, then, the primary side clearance. If a nose radius is required, it should be ground on the same wheel.

Finish Grinding. For the finish-grinding operations which follow, a slightly harder bond, silicon carbide wheel is used. Alternatively, the tool may be finish lapped on a metal-bonded diamond wheel.

Provided that tools are withdrawn from service at the correct time, finish grinding or lapping is all that is required to re-sharpen them for further use. The sequence is the same as for rough grinding, namely: grind cutting rake; grind front clearance; and grind nose radius, if required. In connection with the cutting rake, the previous remarks apply. It is not necessary to grind the secondary clearance again. Once more, it is emphasized that for all carbide grinding operations, and particularly off-hand grinding, the lightest possible pressure should be used.

Grinding Primary Rake. The provision of primary and secondary cutting rakes is proving extremely successful as a means of improving carbide tool performance. When employing a tool with a negative cutting rake, a secondary positive rake can be applied to relieve chip pressure. The required cutting rake is then left as a negative primary land, as indicated in Fig. 6, and its width is normally three to four times the feed.

## MODIFYING STANDARD TOOLS BY OFF-HAND GRINDING

For certain operations, tools may be wanted with shapes that are not included in the standard range, or a tool may be needed urgently with a standard shape which is not carried in stock. In such

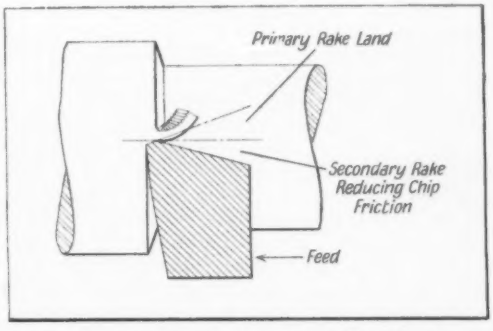



Fig. 6. Diagram Showing a Tool with Negative Primary Land

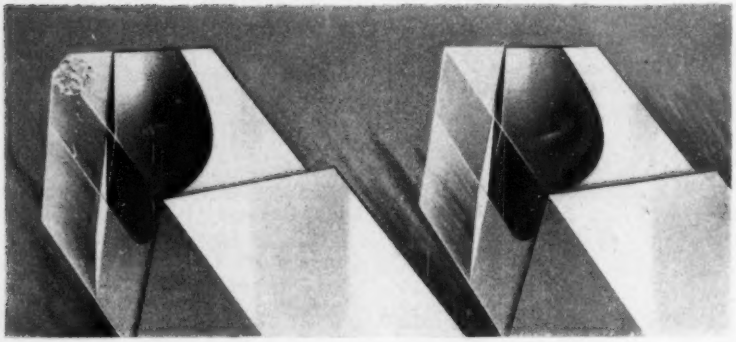


**Fig. 7. A Tool which has been Badly Chipped or Broken Can Often be Reclaimed by Grinding to a Different Shape**

cases, it is usually possible to modify an available tool to obtain the shape required. Tools which have become badly chipped or broken in service, moreover, can usually be reclaimed by grinding them to a different shape, as seen in Fig. 7.

When a special shape is needed, a tool should be selected which can be modified with the least amount of grinding and wastage of carbide. In this connection, it should be remembered, for example, that an approach angle need only be of sufficient length to accommodate the depth at which it is proposed to cut.

Some modifications, such as alterations to cutting rake, plan-approach or plan-trail angles, or clearances, are performed by off-hand grinding, in the manner already described.

If a large amount of material must be removed, the operation should be performed in stages, as indicated in Fig. 8, so that a single face of the tool is not subjected to continual grinding and consequent excessive heating. It is necessary to relieve the shank material with an aluminium oxide wheel when a tool shape is being modified by grinding.

## MACHINE GRINDING

Whereas off-hand grinding can be employed for re-servicing tools where accuracy of form is relatively unimportant, the method is not suitable if geometric accuracy of tool form must be maintained. For such operations, control of relative movement between the tool and the grinding wheel is essential.

Form tools are normally re-serviced on tool and cutter grinders, and sometimes on profile grinders. In many respects, machine grinding is ideal for re-servicing carbide tools, since the whole operation is under strict control. The rate at which the tool is traversed over the face of the wheel does not vary from one pass to another, and the amount of in-feed of the wheel is always the same.

From the standpoint of grinding wheel performance, these controlled conditions enable the optimum results to be obtained. Soft-bond resin wheels can be used without the fear of damage, and their rapid cutting properties can be exploited fully. Despite these advantages, the setting-up time for machine

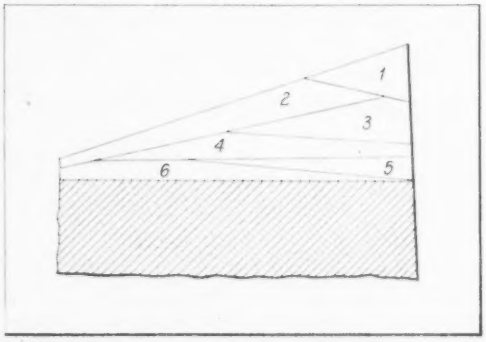



**Fig. 8. If a Large Amount of Material Must be Removed, the Operation Should be Performed in Stages, as Indicated**

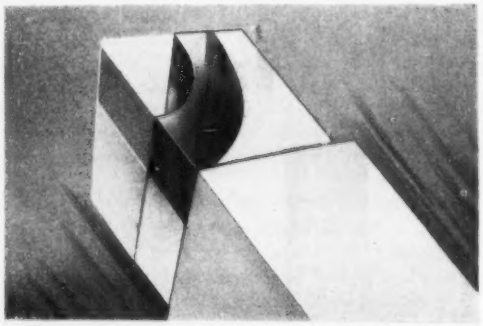
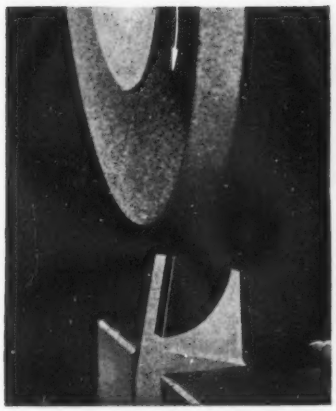
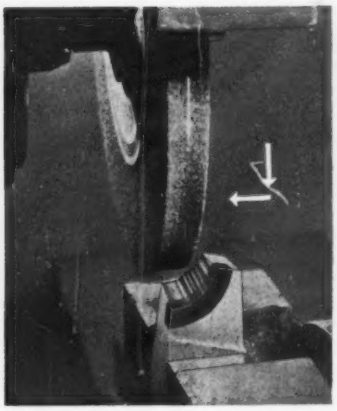


**Fig. 9. Form Tool with Concave Radius Produced from a Standard Bar Turning Tool**





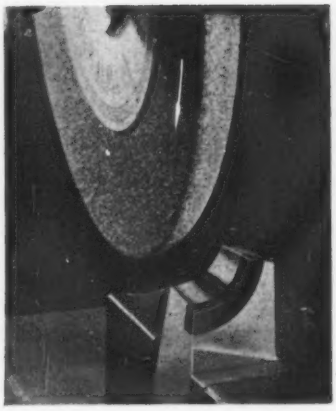


**Fig. 10. (left) Set-up for Grinding the Concave Form Tool. Fig. 11. (centre) Method of Rough Grinding. Fig. 12. (right) The Tool is Finished with a Formed Wheel**

grinding is not warranted for simple turning tools, for which the off-hand process gives quite satisfactory results.

## MODIFYING TOOLS BY MACHINE GRINDING

When complex modifications to standard tools are required, it may be necessary to perform the operations on a tool and cutter grinder, surface grinder, or profile grinder.

The form tool shown in Fig. 9, which has a concave radius, is produced from a standard bar turning tool, on a tool and cutter grinding machine. In this instance, it is not possible to relieve the shank material with an aluminium oxide wheel, so that both shank and tip must be ground together. For this operation, the tool is held in a universal vice set to give the desired clearance angles. As previously mentioned, the direction of wheel rotation must be such that it grinds into the cutting edge of the tool, as indicated in Fig. 10, in order to prevent slight flaking of the carbide.

Grinding is carried out downwards and outwards, as shown in Fig. 11. This procedure reduces the rate of wheel wear, which is usually very high for such operations, and the wheel is not form dressed until the tool is approaching the final shape.

If an accurate form is required, the wheel must be shaped with a radius attachment, but where the limits for form permit, it may be dressed by hand, using a Carborundum stick. It is sometimes advisable, when form grinding, to employ a slightly harder grade of wheel for the finishing cuts, so that the rate of wheel wear is reduced. Fig 12 shows the formed wheel in use.

Another example, indicating the methods employed for modifying standard bar tools by machine grinding, will now be considered. In this case, a bar tool is to be modified to form a parting and chamfering tool, as in Fig. 13, and the sequence of operations is as follows: (1) The tool is set in a universal vice, so that the required clearance angles are obtained (Fig. 14), and an aluminium oxide wheel is employed initially. (2) Grinding is performed, downwards and outwards, with an unformed silicon carbide wheel, until the point is reached at which the radius is to be produced at the neck of the tool. (3) After the radius has been formed on the wheel, as previously described, finish grinding is carried out (Fig. 15). (4) The tool is re-set in the vice, for grinding the opposite side, and the same procedure is followed, the chamfer finally being produced with a formed wheel

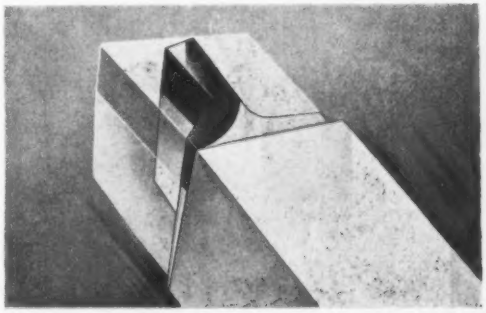
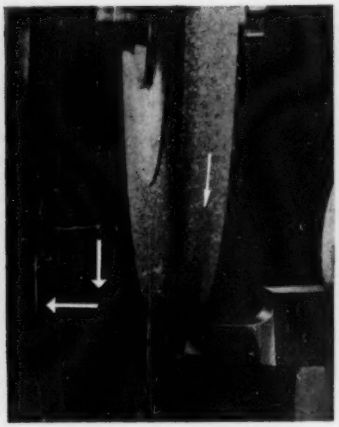


**Fig. 13. Bar Tool Modified to Form a Parting and Chamfering Tool**



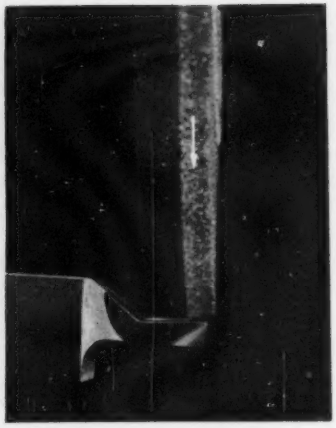


**Fig. 14. (left) The Tool is Set in a Vice at the Required Clearance Angles. Fig. 15. (centre) The Radius is Finished with a Formed Wheel. Fig. 16. (right) The Chamfer is Ground with a Formed Wheel**

(Fig. 16). (5) Then, it remains only to grind the front clearance, and this is done by the off-hand method (Fig. 17).

### GRINDING MULTI-TOOTH TOOLS

In the preceding sections of this article, the re-servicing techniques for bar-type turning tools have been considered. The grinding procedure for reamers, milling cutters, and similar end-cutting tools will now be described. Such tools are always re-serviced on tool and cutter grinders, and resin-bonded diamond wheels are recommended for this class of work.

End Mills. In Fig. 18 is shown a spiral end mill, mounted between centres on a tool and cutter grinder. The tool is prevented from turning by a spring-loaded finger, attached to the wheelhead. With a tooth of the tool resting on the finger, the table is raised to obtain the desired clearance, the machine is set to remove between 0·0005 and 0·001 in. per pass, and the spiral flute is kept in contact with the spring-loaded finger while grinding is in progress. The same procedure is followed for each tooth on the tool.

Then, it is necessary to grind the end cutting edges of the tool, and, for this operation, the spring-loaded finger is attached to the work table as can be seen in Fig. 19. The workhead of the machine is tilted to give the required end clearance angle, and each tooth is ground until all evidence of wear has been removed.

Milling Cutters. When a milling cutter is ground, it should be indexed, from blade to blade, against a spring-loaded plunger. Small equal amounts of material should be ground from each blade, until all have been re-sharpened, and the cutter should then be checked for concentricity.

The procedure is as follows:—(1) For grinding the faces of the blades (Fig. 20) the cutter is mounted on the workhead of the machine, with the face to be ground parallel to the face of the lapping wheel. (2) Next, the peripheral surfaces are ground, with the spring finger attached to the

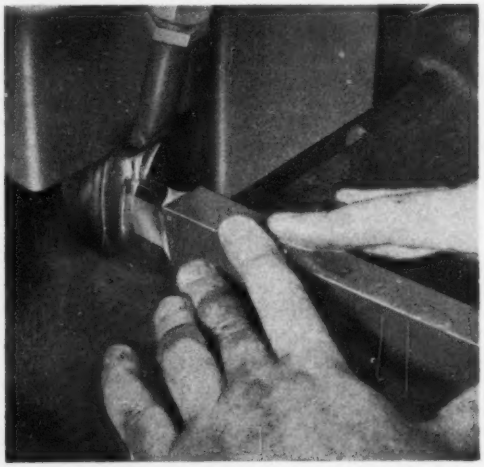
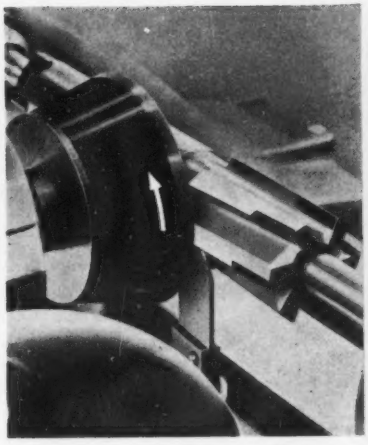


**Fig. 17. The Front Clearance is Ground by the Off-hand Method**



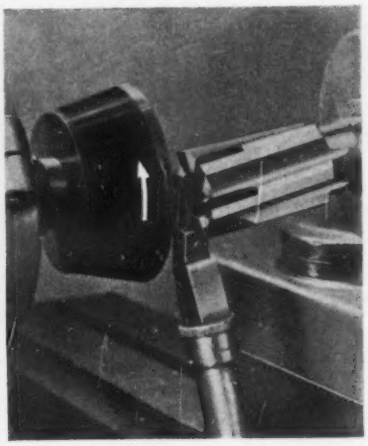


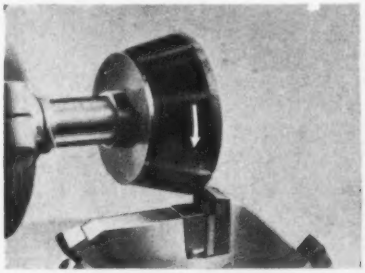
**Fig. 18. (left) Spiral End Mill Mounted Between Centres on a Tool and Cutter Grinder**

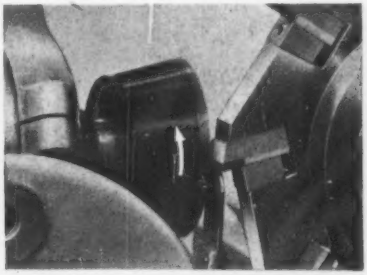
**Fig. 19. (right) Set-up for Grinding the End Cutting Edges**

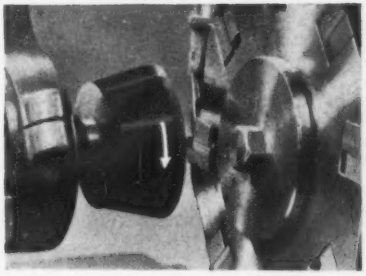
wheel head, as shown in Fig. 21. The desired clearance is obtained by adjusting the table height. (3) The spring finger is attached to the workhead, as shown in Fig. 22, when grinding the side face. The clearance angle is obtained by tilting the table of the machine. (4) Finally, the chamfer is ground (Fig. 23). For this purpose, the spring finger is attached to the table of the machine, which is adjusted to give the required clearance. The workhead is then rotated through 45 deg., and the chamfers ground to the specified width.

FACE MILLING CUTTERS. The following method is used for re-servicing face milling cutters:—With the workhead set at the required helix angle and radial rake, the faces of the blades are lapped in turn (Fig. 24). Next, the workhead is swung over to the required bevel angle, and the finger, which is attached to the head, is adjusted to obtain the required clearance. With this setting, the bevel angle on each blade is lapped in turn (Fig. 25). Then, with the workhead at 45 deg., the finger attached to the head, and the cutter at the required clearance angle, the chamfer on each blade is lapped (Fig. 26).

Finally, the workhead is set at 90 deg. less the amount required to give in-rake or dish, with the







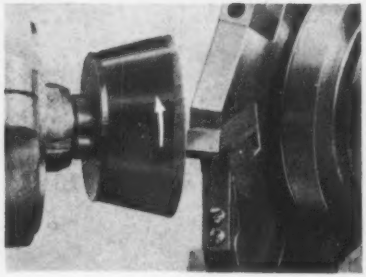
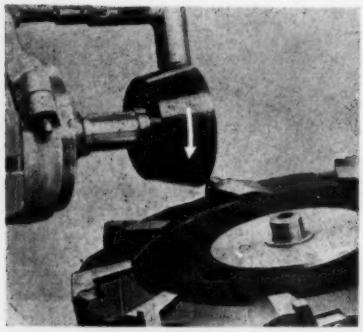


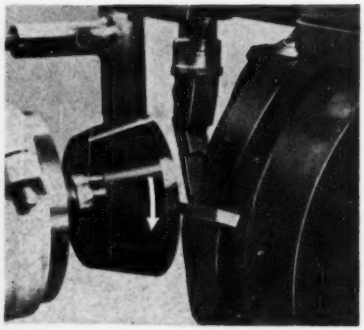
**Fig. 20. (top left) Grinding the Face of a Milling Cutter Blade**

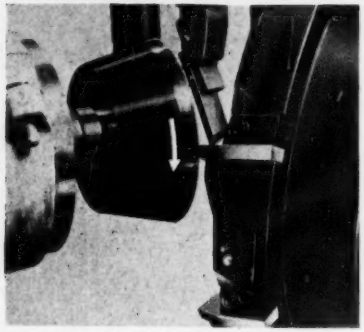
**Fig. 21. (top right) Grinding the Peripheral Surface**

**Fig. 22. (bottom left) Grinding the Side Face**

**Fig. 23. (bottom right) Grinding the Chamfer**







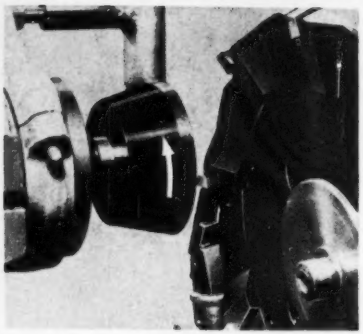


**Fig. 24. (top left) Set-up for Lapping the Front Surface of a Face Milling Cutter Blade**

**Fig. 25. (top right) Lapping the Bevel Angle**

**Fig. 26 (bottom left) Lapping the Chamfer**

**Fig. 27. (bottom right) Lapping the Blade Clearance**

cutter tilted to the required angle, and the blade clearance is lapped (Fig. 27).

## CHIP BREAKERS

Most metals possess characteristics which result in the production of a continuous chip during machining. For ease of disposal, and to protect the operator from injury, the continuous chip must either be curled, or broken into short lengths. Chip breaking can sometimes be ensured by increasing the feed to obtain an increase in cross-sectional area (feed × depth of cut). Alternatively, a chip breaker may be formed or ground in the tool tip. Chip-breaker widths are varied, depending upon the feed and depth of cut, and some typical forms are shown in Fig. 28.

Where extreme difficulties are experienced in breaking the chips, various methods of chip-flow control can be adopted, and involve the provision of deeper and wider grooves than those associated with chip breakers, with blending radii or inclined step faces. These grooves are known as chip curlers.

As so many variables, including degree of duc-

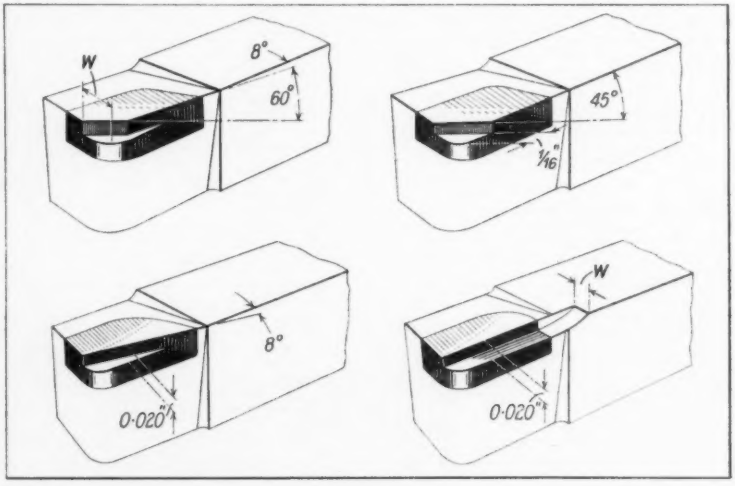



**Fig. 28. Some Typical Chip-breaker Forms. The Dimension *W* Depends on the Feed and Depth of Cut**

tility, feed, speed, depth of cut, and diameter of workpiece are involved, the correct form in any particular instance can only be determined by practical trials.

Chip breakers, or curlers, can be ground on conventional machines which have provision for correct angular setting of the tool. Alternatively, special chip-breaker grinding machines are available. Special metal-bonded wheels are recommended for grinding chip-breaker grooves in tools, but the operation can also be carried out with a resin-bonded peripheral-type wheel.

### RE-SERVICING TOOLS BY SPARK-EROSION

The spark-erosion method of machining is comparatively new, and is not so well known as the long-established grinding techniques. With this process, metal is removed by means of an electrical spark discharge which occurs between an electrode and the work. Although the mechanics of metal removal by this method are beyond the scope of this article, it may be noted that it is now firmly established as a production process. Spark-erosion is employed for a variety of operations involving hard metals, where normal machining would be difficult or impossible. Typical applications of the process include the reconditioning of extrusion dies, and the machining of intricate shapes in carbide and other hard materials.

A feature of the electro-erosion process is that the work and electrode are not in physical contact, as there is always a spark gap between them. This gap is filled with a suitable dielectric fluid, through which the spark discharge takes place. If the electrode and workpiece touch, there is a short circuit, no sparking can occur, and no metal removal takes place.

The equipment used for re-servicing carbide tools by the spark-erosion process closely resembles a conventional off-hand grinding machine, but the wheel is replaced by a circular electrode, made from cast iron. Suitable electrical gear is incorporated in the machine, the output from which serves to energize the rotating circular electrode. Provision is also made for directing a copious flow of dielectric fluid over the face of the electrode, and over the tool. The Wickman Erodosharp Mark II machine is shown in Fig. 29.

Tool sharpening with this equipment is also similar to conventional grinding. As sparking occurs, material is removed from the tool. Some metal is also removed from the electrode, but the quantity is very small, so that the life of an electrode is considerable. Experience has shown that, under average conditions, an electrode life of 8,000/10,000 tools is obtained. If the majority of tools processed require the removal of large amounts of stock, the electrode life is reduced to some 5,000 tools.

**Fig. 29. Wickman Erodosharp Mark II Machine for Re-servicing Carbide Tools by Spark Erosion**

A further advantage of spark-erosion as a method of re-servicing carbide tools is that no heat is generated in the tool material during processing, so that the danger of cracks being formed in the tip, due to thermal shock, is eliminated. Because there is no physical contact between the tool and the electrode, moreover, problems of "wheel loading" do not arise. It is possible, therefore, to remove metal from both tip and shank simultaneously, and the need for two operations, as in grinding, is avoided.

### SURFACE FINISH AND CUTTING EDGE

The surface finish produced by the spark-erosion process is of a different character from that associated with more conventional machining methods. With spark-erosion, numerous small saucer-shaped depressions are formed, with a depth of approximately one third the diameter of the associated sphere. This type of surface is shown diagrammatically at the top in Fig. 30. Enlarged photographs of an eroded surface and one produced by normal grinding methods are also illustrated in Fig. 30. The eroded surface is dull and non-

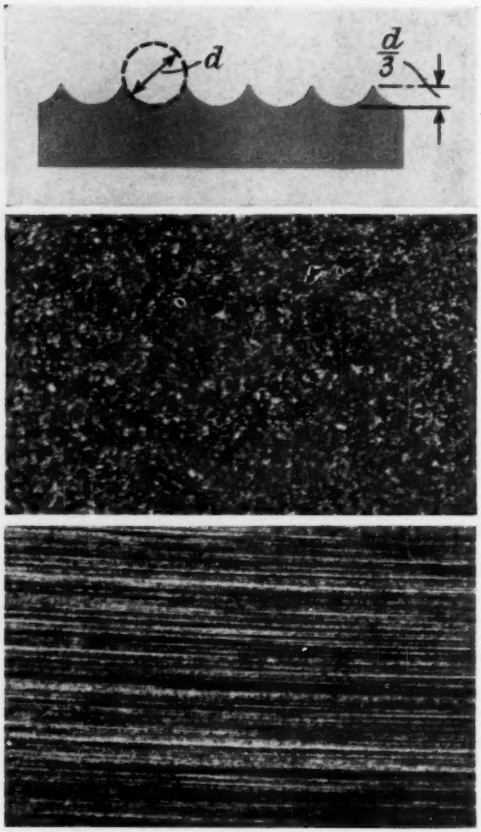



**Fig. 30. (top) Diagram of Surface Produced by Spark Erosion. (centre) Photomicrograph (25×) of Coarse Spark-eroded Surface. (bottom) Photomicrograph (25×) of Surface Produced by Normal Grinding**

reflective, and resembles a fine shot-blast finish. On account of this unconventional matt finish, doubts have been expressed as to the suitability of the spark-erosion process for re-servicing carbide tools. Results which have been achieved with eroded tools, both in this country and in the United States, however, have clearly established the fact that spark-erosion is a sound and practical process.

Since the degree of roughness on an eroded workpiece depends upon the intensity of the spark discharge, it is possible to control the surface quality. Heavy discharges result in rapid metal-removal, but the surface finish produced is rough, and the converse also applies. In consequence, a spark-erosion, tool re-servicing machine is provided with a selector switch to alter the intensity of the spark discharge, so that it is possible to remove the bulk of the material rapidly at the "coarse" setting, and to obtain the final finish with a "fine" setting, which gives a spark of lower intensity.

Considerable caution is necessary in making comparisons of the surface-finish readings for eroded and conventionally-processed surfaces. It is possible, for example, for the tracer needle of a surface-analyzing unit to bridge a deep, hair-line crack, so that a misleadingly low centre-line-average figure is obtained. The presence of such hair-line cracks is not of major importance on the flat surfaces of tools, but they may cause crumbling at the cutting edge of the tool, with consequent deterioration of performance.

This point will be appreciated better if reference is made to Fig. 31, in which are shown magnified portions of two cutting tools processed by

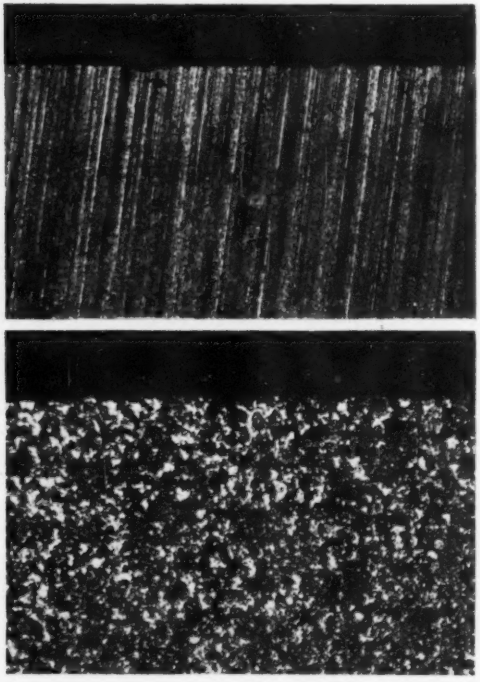


**Fig. 31. (top) Photomicrograph (50×) of the Cutting Edge of a Conventionally Ground Tool (Surface Finish, 20 micro-inches, C.L.A.). (bottom) Photomicrograph (50×) of the Cutting Edge of a Tool Sharpened by Spark Erosion (Surface Finish, 50 micro-inches, C.L.A.)**

conventional means and by spark-erosion. It will be seen that the conventionally-ground tool has several irregularities on the cutting edge, whereas the eroded tool shows a more uniform edge. The centre-line-average surface readings for these two surfaces, it may be noted, are 20 and 50 micro-inches respectively.

For machining operations involving coarse feeds —for example, planing—an eroded tool will be found satisfactory, but for fine feeds, up to about 0·010 in., it may be desirable to re-service tools by both spark-erosion and diamond-lapping methods. The bulk of the material can be removed by erosion, and careful diamond lapping with a fine, or superfine, grit wheel can then be carried out, to obtain a highly-polished land adjacent to the cutting edge.

The examples in the accompanying table indicate that, in general, the spark-erosion process can be utilized for tool re-servicing, with results which are equal to, or better than, those obtained by conventional grinding.

EXAMPLES OF RESULTS OBTAINED WITH GROUND AND SPARK-ERODED TOOLS

| Component | Operation | No. of pieces produced | |
|---|---|---|---|
| | | Conventional ground tool | Spark eroded tool |
| Cast-iron flywheel | Rough facing | 305 | 404 |
| Steel gear-shaft | Rough turning | 75 | 80 |
| Steel plate | Milling | 510 | 550 |
| Cast-iron camshaft | Facing ends | 325 | 575 |
| Flywheel ring gear | Finish turning inside diameter | 170 | 170 |
| Cast-iron flywheel | Rough facing | 287 | 365 |

## CONCLUSIONS

(1) In view of the high cost of diamond wheels, any steps taken to reduce the wear and tear on such wheels will result in appreciable savings.

(2) For work involving feeds in excess of 0·010 in., the surface finish and the cutting edge produced by spark-erosion methods are satisfactory, without subsequent diamond lapping. To use diamond wheels in these circumstances is wasteful, and, if spark-erosion is adopted, it may be possible to achieve savings.

(3) For work involving feeds below 0·010 in., a diamond-lapped tool is normally desirable. When re-servicing such tools, economies can be effected by first employing the spark-erosion process for removing the bulk of the material, with subsequent diamond lapping to produce a land adjacent to the cutting edge of the tool. In this way, diamond consumption can be reduced to a minimum.

(4) The time required for "grinding" by spark-erosion is somewhat longer than for conventional methods. This drawback is off-set, however, by the fact that "grinding" can be carried out continuously, without the danger of overheating. In addition, since the shank and tip can be ground simultaneously, only one operation is needed, whereas two are required with normal grinding.

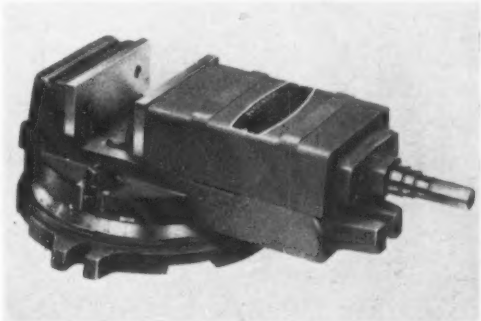
(5) The replacement cost of a spark-erosion electrode is low—about one-twelfth of that of a diamond wheel—and it has a long life.

Thus, it will be evident that whereas the spark-erosion process cannot be regarded as superseding diamond lapping, by employing the two methods in combination, savings in diamond wheel costs can be made.

## New Progress Machine Vices

A new range of Progress machine vices, one of which is shown in the figure, has been introduced by B. Elliott & Co., Ltd., Victoria Works, Willesden, London, N.W.10.

The subject of a patent application, these vices have detachable swivel bases, and are made in four sizes, which will accommodate workpieces up to 2, 3½, 5 and 6½ in. thick. They are available with 3-, 4½- and 6-in. wide by 1¾-, 1½- and 2¼-in. deep jaws. The moving jaw slides on flat guideways, which extend for its full width, so that a large area is provided for supporting the work. The design is such as to obviate risk of the jaw being lifted from the guiding surfaces when clamping pressure is applied. Graduations are provided on a bevelled portion of the swivel base.



**An Example from the New Range of Progress Machine Vices**

# New Burnerd Multisize Collet Chuck

The Multisize collet chuck shown in Fig. 1, has been introduced recently by F. Burnerd & Co., Ltd., 5 Balfour Place, London, W.1. It is intended for use with a range of patent collets of entirely new design, one of which is seen in Fig. 2.

With this design of collet, the work is gripped by a number of narrow, wedge-shaped blades, which can be moved radially in equally-spaced slots. An important feature of the arrangement is that a uniform gripping pressure is applied, over the entire length of the blades, to workpieces with diameter variations of as much as ⅛ in. A total of only 11 collets is provided for gripping all diameters from ¾ to 1½ in. Collets of other sizes will be available shortly.

Either six or eight blades are incorporated, depending on the size of the collet, and their inclined outer edges are held in contact with a taper bore in the body of the chuck by torsion springs. Axial movement of the collet, for gripping the work, is effected by the action between an internally-threaded ring and a sleeve with an internal flange at the nose end. This sleeve surrounds a reduced-diameter portion of the body, and is prevented from rotating by means of a key. A cross-hole is provided in the body to take a chuck key, which meshes with gear teeth of the collet. The ring turns on steel balls, which at the rear end of the ring for opening and closing engage tracks in the bore and on the chuck body, and, in addition, serve to prevent axial movement.

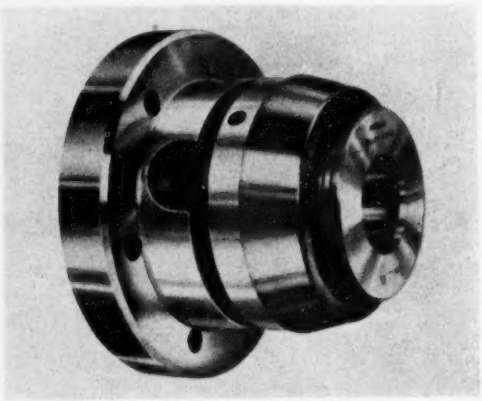


**Fig. 1. Burnerd Multisize Collet Chuck**

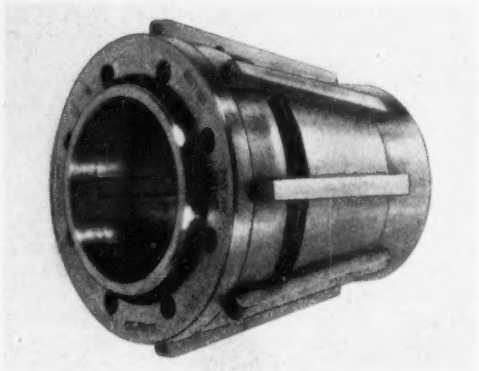


**Fig. 2. One of the New Burnerd Collets for Use with the Multisize Chuck Shown in Fig. 1**

The gripping pressure applied to the work enables heavy cuts to be taken without risk of slip or vibration, and it is stated that concentricity of the piece within 0·0005 in. is obtainable at a distance of 4 in. from the nose end of the collet. An adjustable end-stop for the work is available, which takes the form of a disc fitted with a central bolt and a locking screw. Spring-loaded balls are provided round the periphery of the disc which engage with an internal recess in the body of the chuck, and thus provide for endwise location.

The body is available in different designs, one of which has a flange, at the rear end, whereby the chuck can be mounted on a faceplate, for example. Alternatively, chucks can be provided for mounting on lathe spindles with American type A1, type D1 cam lock and type L long taper noses.

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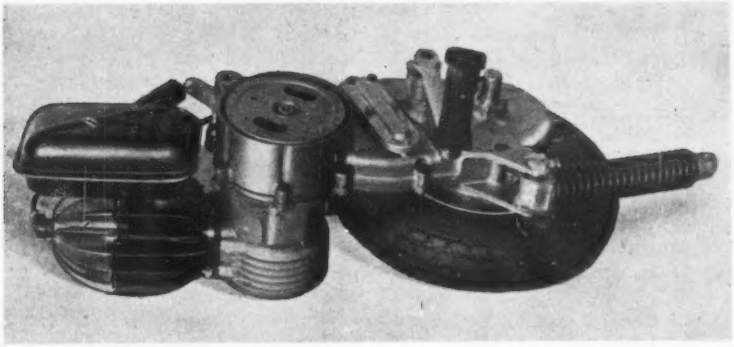
ELECTRICITY GENERATED FOR PUBLIC SUPPLY and sent out during October last totalled 7,603 million kilowatt hours, as compared with 7,205 million and 6,598 million in October, 1956 and 1955 respectively. The simultaneous maximum load during the month was 17,376 megawatts, as against 17,347 and 16,059 for the earlier periods. At the end of October installed capacity amounted to 25,861 megawatts, whereas the corresponding figure for the end of 1952 was 17,740.



# Typical Operations on Components for Piatti Motor Scooters

***Methods Employed by Cyclemaster, Ltd.***

The Piatti all-British motor scooter is being produced by Cyclemaster, Ltd., at Byfleet, Surrey, in a modern factory, equipped with plant specially installed for the purpose. The factory is a self-contained organization, comprising administrative offices, design department, production and assembly shops, despatch bay, stores, and service depot.

Certain parts of the Piatti scooter, notably the ignition equipment, pressed steel body shell, and road wheels, are obtained from outside sources, but the engine, gearbox and final drive sub-assembly, and front suspension unit are produced within the works. The integral engine and transmission unit is mounted in the body shell at three points, of which the front two, provided with Silentbloc bushes, are located behind the engine cylinder. The third mounting point is connected to an abutment at the rear of the frame, through the rear spring. This mounting arrangement offers several advantages, and enables the entire propulsion unit to be attached to, or released from, the body. The latter, it may be noted, is a rigid pressed steel shell, internally stiffened by cross members and gussets, the whole forming a stable structure, to which various sub-assemblies are attached.

Measuring 55 in. long by 24½ in. wide, this motor scooter weighs 180 lb., and has a maximum road speed of 45 m.p.h. Power is provided by a single-cylinder, air-cooled, horizontally-mounted 2-stroke petrol engine, with crankcase compression, which develops 4·75 b.h.p. at 4,750 r.p.m. Of 2 per cent nickel iron, the cylinder has a bore of 51 mm., and is secured to a light-alloy crankcase by four studs. It has a detachable head, made from light alloy, and the split-skirt piston, of aluminium silicon alloy, is fitted with two compression rings, the upper ring being chromium plated. The bosses of the H-section connecting rod are bored and ground, to accommodate a cage-type needle roller bearing for the large end and a wrapped phosphor-bronze bush for the small end, and a gudgeon pin of ample dimensions is located in the piston by two circlips.

Some of the operations performed in the production of the final drive spindle, also the crankshaft, which is machined to close tolerances from a forging in En. 8 D steel, are described in this article. Set-ups for machining the crankcase casting, cylinder, and front-suspension swinging arm are also discussed.

## PRODUCTION OF THE FINAL DRIVE SPINDLE

In Fig. 1 are shown the principal dimensions and tolerances of the final drive spindle, which is machined from 1¼-in. diameter En. 24 bright steel bar. The spindle blanks are produced to length, and centred and faced at one end, on a Wickman automatic, and are centred at the opposite end on a capstan lathe. Next, turning operations are carried out, in two stages, on a Drummond Maximinor multi-tool lathe, equipped with front and rear tool slides, the layout for the first stage being

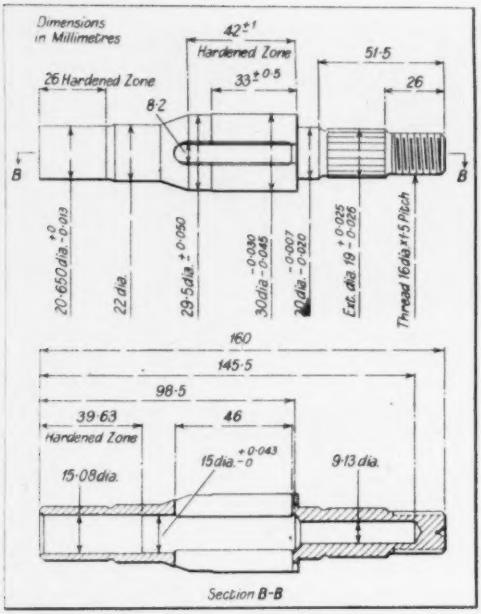



**Fig. 1. The Final Drive Spindle in Elevation and Section**

shown in Fig. 2. With the work gripped in a driver, four diameters of 20·650 mm., 22mm., 29·5 mm. and 30 mm. are turned, with four tools held in a block on the front slide, at a spindle speed of 708 r.p.m. Each of the diameters turned with this set-up is 0·010 – 0·012 in. greater than the final size, to allow for subsequent finishing on a Newall type L plain-grinding machine. The 20-deg. taper on the spindle and the undercut are produced by two form tools, held in a box on the rear slide, which are fed in to depth when the turning cuts with the front tools have been completed. All tools employed at this set-up, and for the subsequent turning stages, are tungsten-carbide-tipped.

In preparation for the next multi-tool turning operation, the opposite end of the spindle is broken down to a diameter of $\frac{13}{16}$ in., over a length of 2¼ in., on a Maximinor lathe. The work is again gripped by a driver, and the cut is completed with a single tool on the front slide, in 72 sec. at a work speed of 708 r.p.m. Subsequently, the three diameter steps on the reduced portion of the shaft are turned, also on a Maximinor lathe. Three single-point tools on the front slide produce the 16-mm. diameter at the end of the component, on which a thread is later rolled, also the 19-mm. and 20-mm. diameters. On the 16-mm. diameter, it may be noted, a tolerance of 0·0015 in. is held. In addition, there are three tools on the rear slide which serve to produce a 45-deg. chamfer at the end of the spindle, an undercut between the second and third diameter steps, and a shoulder leading up to the largest diameter. At this set-up, it may be pointed out, the work is held in a driver, as before, and is located endwise against a stop, through which protrudes the point of a spring-loaded headstock centre. The time for this operation is 45 sec.

Both the 16-mm. by 1·5-mm. pitch thread at the end of the spindle, and the 48 serrations (to B.S. A19) on the adjoining portion, are produced on a Steinle No. 1 thread rolling machine.

Using tooling supplied by the makers, a Herbert 2D capstan lathe is employed for drilling and reaming a stepped hole along the axis of the spindle, which is held in a 7½-in., 3-jaw, air-operated chuck. A standard length $\frac{33}{64}$-in. diameter drill, a $\frac{17}{32}$-in. by 9½-in. drill, and a $\frac{33}{64}$-in. by 10⅝-in. drill provide for removing the bulk of the metal. The bore is then sized over a distance of 98·5 mm.

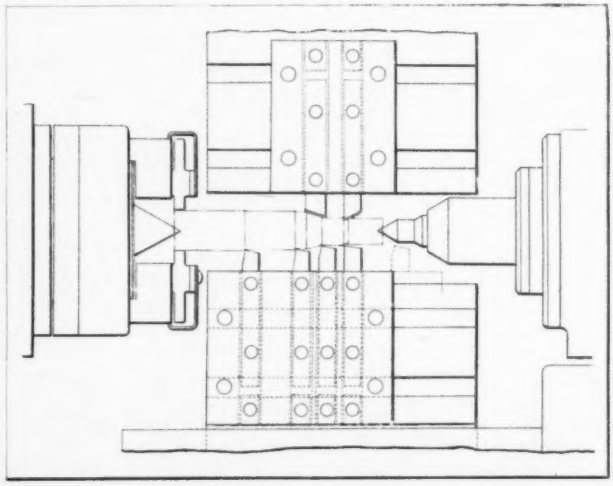


**Fig. 2. Tool Layout on a Drummond Maximinor Lathe for the First Turning Operation on the Final Drive Spindles**

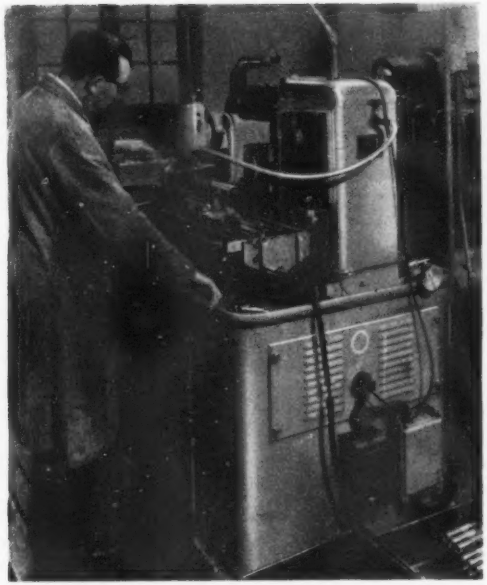


**Fig. 3. Centec 3R Production Milling Machine Set Up for Producing Slots in Opposite Sides of the Final Drive Spindle**

with a semi-finish reamer and a Coventry expanding reamer. Finally, the outer portion of the reamed bore, over a distance of 39·63 mm., is opened out to a diameter of 15·08 mm., and is checked by means of a special double-ended plug gauge. The complete drilling and reaming sequence occupies 5 min. 12 sec.

The 8·2-mm. wide, opposed slots in the spindle are produced on the Centec 3R production milling machine seen in Fig. 3. On this machine, the work is held at one end in a Centec air-operated indexing head, and the other end is supported by a tailstock centre. The automatic working cycle, which is initiated by the operator, is controlled hydraulically. A Clarkson end-mill of special size is employed, and the head descends rapidly until the tool is about to start cutting, at which point the feed rate is engaged. The end-mill is plunged into the work until it breaks through into the bore. Next, the down feed is interrupted, and the longitudinal table traverse is engaged to mill the slot to length. At the completion of this stage, a stop on the front of the table trips a micro-switch, and the head is returned to the starting position. Then, the operator indexes the work through 180 deg., by means of the pneumatic head, to present the other side for slotting, and starts the automatic working cycle again. With this set-up, slots are cut in ten spindles per hour.

A square end, with radii of 1·5 mm. in the two corners, is produced at one extremity of the slot by a broaching operation, which is performed on an Edgwick machine, with tools supplied by Coventry Tool & Gauge Co., Ltd. The limits on the broached form are ±0·1 mm.

Burrs and roughness are then removed from the slot by hand, preparatory to heat treatment, during which the part is first generally hardened and tempered to 32/36 Rockwell C, and subsequently hardened to 58±2 Rockwell C, over specified zones, with high-frequency induction equipment. Then, the spindles are inspected, and random samples are sectioned lengthwise, and the exposed surfaces etched to reveal grain structure. After the four diameters and a shoulder have been ground on the Newall machine, Solex external air-gauging equipment is employed for checking the 20·65-mm. and 30-mm. portions, which are held to close tolerances. The two other diameters are checked with adjustable gap gauges. Finally, the spindles are deburred, polished, and washed.

## OPERATIONS ON THE CRANKSHAFT

The crankshaft is machined from an En. 8D steel forging to the dimensions shown in Fig. 4. It is inspected for flaws before being passed to a Herbert milling machine, equipped with a Centec air-operated vice, on which it is faced to length. Next, the larger end of the component is spotfaced and centred, and the opposite end is faced on a Herbert No. 4 capstan lathe, in 45 and 60 sec., respectively. For turning and facing the balance weight, and producing a chamfer at the junction of the two surfaces, a Drummond Maximinor lathe is employed. The outside of the web is turned with a single front tool, and two rear tools are fed in to face the side of the web and produce the chamfer. For this operation, the work is rotated at a comparatively low speed, and Stellite-tipped tools are used to withstand the interrupted cutting. The floor-to-floor time is 126 sec.

With a tool mounted on the front slide of a Maximinor lathe, the spindle portion of the crankshaft then is reduced from the rough forged size to a diameter of $\frac{1}{16}$ in., over a length of $3\frac{7}{8}$ in. from the smaller end of the component. A second tool is brought into operation, shortly before the end of the traverse, to bring the end of the shaft to a diameter 0·020 in. above the size required for subsequent threading.

At a further set-up on a Maximinor lathe, with front and rear tooling, the remainder of the turning

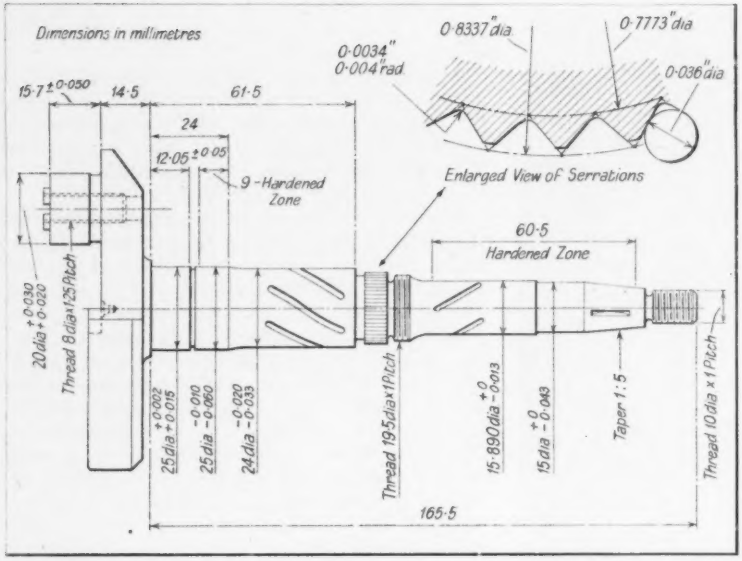



**Fig. 4. A View of the Crankshaft, Showing the Principal Dimensions**

on the long part of the shaft is completed in a floor-to-floor time of 81 sec. The front tools provide for turning eight diameters and one taper during a single traverse. Taper turning is controlled by a former plate and follower, the tool being mounted in a separate slide. The rear slide is equipped with six tools to produce five undercuts and one chamfer.

A Herbert No. 4 capstan lathe, which is provided with a throw fixture, is employed for turning, facing and undercutting the eccentric pin; facing the end of the balance weight; and drilling and tapping an 8-mm. by 1·25-mm. pitch hole in the eccentric pin. An allowance of 0·010 in. on the eccentric pin diameter is left for subsequent finish turning. The 3-mm. wide by 1·8-mm. deep slot across the end of the eccentric pin, and a 3-mm. wide Woodruff keyway in the tapered portion of the shaft, are both milled on a Centec 3R production machine.

Oil grooves are formed on two bearing surfaces by a rolling process on the Steinle No. 1 thread rolling machine mentioned earlier. In Fig. 5, a crankshaft is seen in position between the forming and support rolls, where it is held between centres in a fixture which permits rapid loading and unloading. By this method, batches of crankshafts are grooved quickly and accurately, in an average time per piece of 23 sec. Other rolls are fitted, as necessary, to produce thread forms of 19·5 mm. by 1 mm. pitch, and 10 mm. by 1 mm. pitch, on the component, as indicated in Fig. 4. The grooving rolls seen in Fig. 5 have already produced many thousands of grooves of the correct form without noticeable wear.

Next to the 19·5 mm. diameter by 1-mm. pitch thread, there are 48 serrations, which are cut on a root diameter of 0·777 in. The general form of these serrations is indicated in the enlarged view in Fig. 4, and to ensure that they are accurately centred with the axis of the crankshaft, they are cut on a Sykes V10A gear generator, set up as shown in Fig. 6. The serration cutter is reciprocated at 413 strokes per min., and completes the operation in 2 min. 33 sec. The finished form is checked with "go" and "not go" serration roller gauges.

Subsequently, the crankshaft is loaded into a

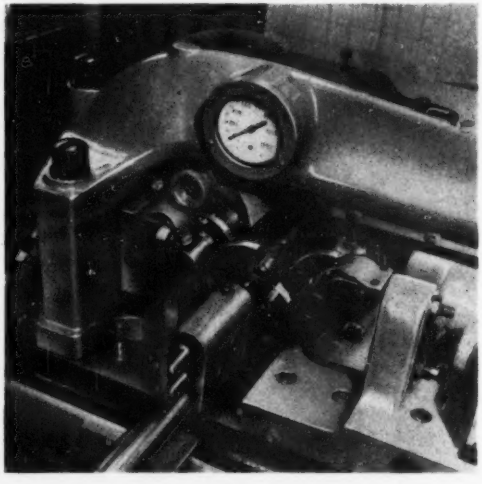


**Fig. 5. Steinle No. 1 Thread Rolling Machine Set Up for Rolling Oil Grooves in the Crankshaft**

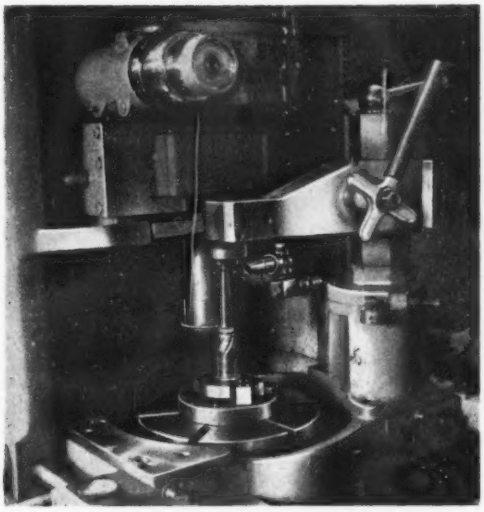


Fig. 6. Set-up on a Sykes V10A Gear Genertinga Machine for Cutting Serrations on the Crankshaft

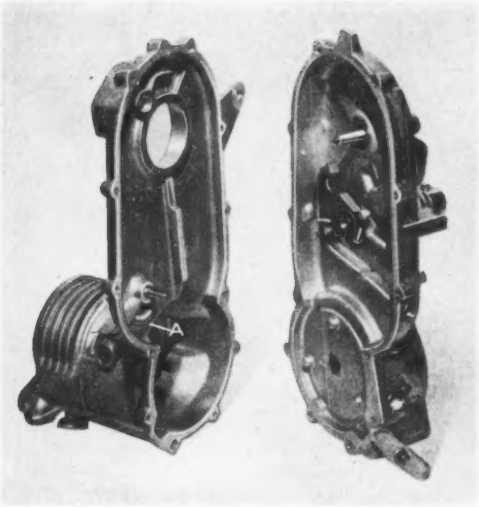



Fig. 7. The Two Portions of the Split Casing which Houses the Transmission and Final Drive

fixture on a Herbert No. 4 Senior capstan lathe, on which the eccentric pin is finish turned. This operation is completed in 2 min. 15 sec., and the pin is reduced to 20 mm. diameter, with limits of +0·030 mm. +0·020 mm. After being deburred, the component is induction hardened to 58/62 Rockwell C to a depth of 0·4/0·65 mm. over the areas indicated in Fig. 4. Finally, five diameters and a taper are finished in a total time of 5 min. 40 sec. on a Newall type L plain grinder.

## MACHINING THE LIGHT-ALLOY CASING

Three Grob two-way drilling, tapping and fine-boring machines are employed for a number of operations on both parts of the light-alloy split casing which encloses the crankshaft, flywheel magneto, clutch, transmission, and final drive. The two halves of the casing are shown in Fig. 7, fully machined in readiness for assembly. An insert, seen at A, is a carbon-steel investment casting in the form of a curved ratchet, which is used in conjunction with a pawl to alter the position of the chain-tensioner arm. The casting on the left in Fig. 7 is shown in Fig. 8, set up on a Grob drilling machine, in a fixture which enables operations to be performed on both faces simultaneously.

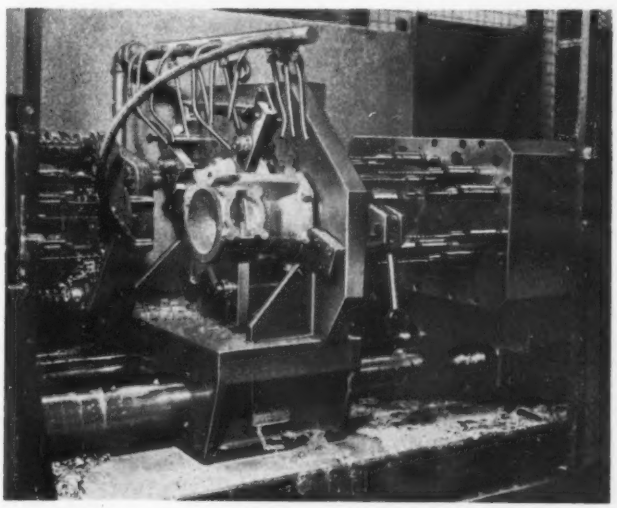


Fig. 8. Set-up for Drilling Holes in Both Faces of One Portion of the Transmission Casing on a Grob Machine

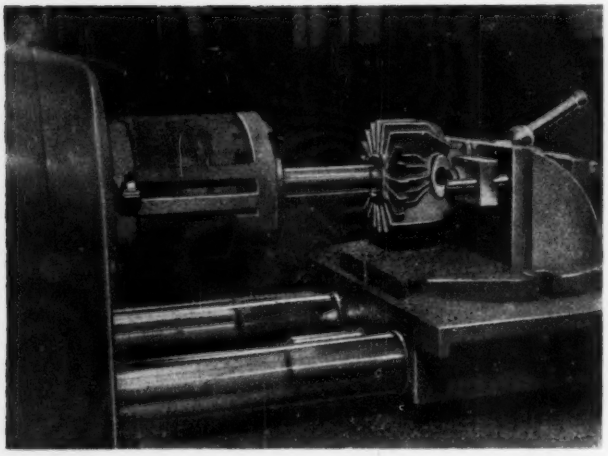


**Fig. 9. Set-up for Boring the Cylinder on a Grob Fine-boring Machine**

In the figure, the work is seen after the completion of the operation during which 18 holes of various diameters on the near side of the casting, and 13 holes on the far side, are drilled in a total time of 77 sec. Next, the holes thus produced are tapped on a Grob machine, of generally similar design, in 69 sec. A Grob fine-boring machine is used to finish the principal shaft holes and ball race bores in the castings which, again, are held in fixtures that are designed to enable operations to be carried out on both sides simultaneously. Certain miscellaneous side holes are subsequently drilled on Archdale and Herbert machines.

## CYLINDER BORING

The cylinders of the two-stroke engine are bored in two operations on Grob fine-boring machines. In Fig. 9, one of these machines is shown set up for rough boring a cylinder, which is held in a fixture by cam-operated clamps. At the conclusion of the boring operation, the fixture is in a position close to the spindle head, and, at this point, a hydraulically-controlled facing tool is applied to machine the joint face on the end of the casting. The spindle speed on this machine is 200 r.p.m., and the feed, 1½ in. per min. Finish boring is carried out on a similar machine, which is fitted with special bearings for the spindle, to ensure the necessary accuracy.

In Fig. 10 is shown a set-up for three boring operations on three different components, which are accommodated in fixtures mounted on a Precimax 3-spindle fine-boring machine. At A may be seen the front suspension swinging arm, which is held in a latch-type fixture and located on two pegs. The 35-mm. diameter hole, through which the front wheel mounting passes, is finish bored with a tungsten carbide-tipped tool, fitted to the head in the foreground, at a speed of 1,050 r.p.m. and a feed of 1½ in. per min. This component is afterwards transferred to a Centec milling machine, on which the spaces between the two lugs at both ends are finished to size with two 6-in. serrated-blade cutters. It may be noted, in passing, that the fixing lugs are subjected to X-ray

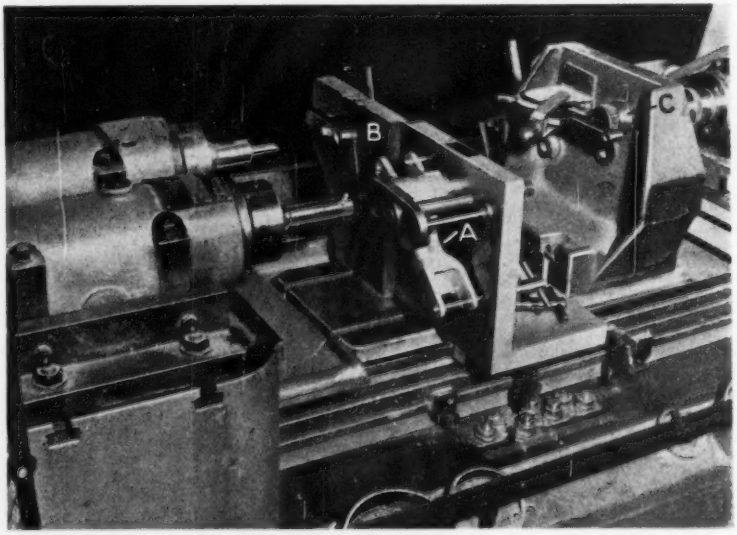



**Fig. 10. A Precimax 3-spindle Fine-boring Machine Equipped with Three Work Holding Fixtures**

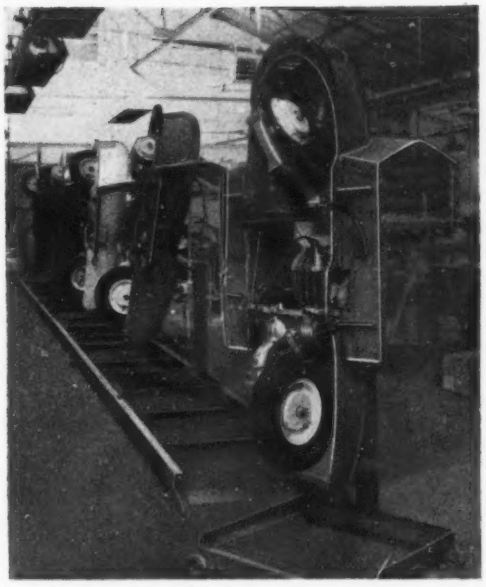


**Fig. 11. A View of the Assembly Line, Showing the Track and Special Fixtures for Supporting the Scooters**

examination for the detection of internal flaws

The fixture at *B*, in Fig. 10, holds a connecting rod while the phosphor bronze bush in the small end is fine bored. For this boring operation, the spindle speed is 2,500 r.p.m., and the feed, 1½ in. per min. In the third fixture, at *C*, may be seen a driving gear fitted with a phosphor-bronze bush. This bush is bored to finished size at the same speed and feed. Although shown mounted together on this machine for the purpose of illustration, the components are not handled simultaneously. One spindle only is used at any one time, and the components are machined in batches.

The assembly line for the scooters is shown in Fig. 11. A track, constructed from opposed channel-section steel girders, braced by T-section spacers, serves to guide the special wheel-mounted assembly fixtures to the various stations. Each fixture has a square base, fabricated from angle iron, to which is welded a vertical tubular column. The latter is provided, at its upper end, with a spigot to engage with a hole in the body shell of the scooter. With the body thus firmly held, the fixture is moved along the assembly line, and is locked in position by a draw bolt at each station, while the various sub-assemblies are attached.

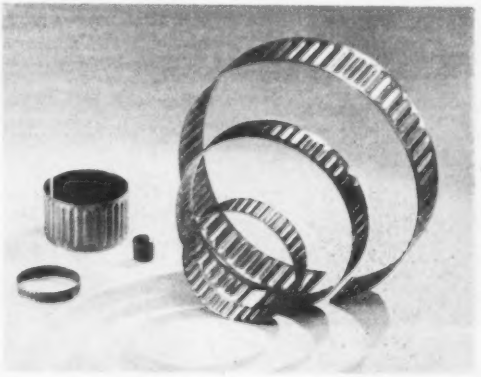
# Star "Tolerance" Rings

George Angus & Co., Ltd., Oil Seal Division, Coast Road, Wallsend-on-Tyne, have recently acquired the sole manufacturing and selling rights in this country for the range of patent "tolerance" rings developed by Deutsche Star Kugelhalter, G.m.b.H., Schweinfurt, Germany.

Available in a variety of sizes up to 3 in. diameter, these rings, some examples of which are shown in the figure, are made from spring steel, of strip form, with a central corrugated portion. In use, a ring is interposed between a bore and the periphery of a mating part, to provide the equivalent of an interference fit for transmitting a predetermined torque. With this arrangement, the need for machining the mating parts to close dimensional limits is obviated, and drive can be transmitted without the use of splines and keys.

The fit obtained, and, consequently, the maximum torque that can be transmitted, depends upon the width of the ring and the extent of compression of the corrugations during assembly. Compensation for small amounts of misalignment between the mating parts is provided by the rings, and the narrow plain portions at their ends prevent variation of the corrugation-pitch during assembly.

Another advantage claimed for the rings is that they obviate risk of slip due to differential expansion caused by tempertaure changes, when the mating parts are made from different metals. For this reason, it is stated, the rings may be used to advantage between the outer races of anti-friction bearings and light-alloy housings. Among other applications of the rings may be mentioned the mounting of pulleys, flywheels, gears, bushes and impellers. They also provide a convenient means of fixing knobs, for instance, to operating levers.



**Some Typical Star "Tolerance" Rings**

# Measurement of Paint Thickness on Aircraft

By N. R. KEEGAN

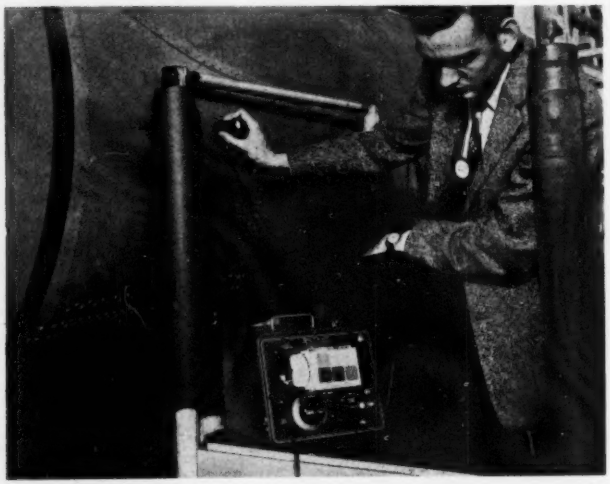
The paint layer on a high-speed aircraft, in addition to being smooth, must be of uniform thickness to close limits. If the thickness varies by only 0·001 in., film failure in the form of cracking and "alligatoring" may occur. This failure, in turn, may reduce the speed of the aircraft by as much as 50 miles per hour, and take-off distance may be increased by as much as 100 yards.

Accurate measurement of paint thickness is thus essential. Tolerances specified by the United States Navy vary with the type of finish, and in some cases are as small as 0·0001 in.

The simplest method of determining thickness is to measure the sheet metal with a micrometer before, and after, it has been painted. Obvious disadvantages are that such measurements are limited to an area near the edge of the sheet, and cannot be made on an assembled aircraft. Another method involves the use of a device which forces a needle through the paint to the base metal, and registers the depth of penetration on a gauge. Apart from the disadvantages that frequent recalibration and needle changing are required, the method is tedious and destructive.

With a third method, which is probably the most widely applied, a portable electronic device produces an oscillating tone when a probe is held against the test surface. The tone is heard through earphones, and is balanced out to the vanishing point by using a potentiometer to control a bridging circuit. Finally, the potentiometer setting is read and applied to a graph, from which the paint thickness is obtained. The disadvantages of this device are that it depends on human hearing, and the necessity of adjusting the graph whenever the device is recalibrated.

Engineers in the Quality Division Laboratory of the Martin Co., Baltimore, Md., U.S.A., recently modified a Boonton film gauge to enable paint thickness to be measured more accurately and conveniently than by other methods. This instrument, originally developed to measure the thickness of metallic plating, was modified and recalibrated for checking organic films. It comprises a probe, indicating meter control, and a set of samples. The probe, which has three feet that rest against the surface to be measured, is an induction coil which sets up an electrical field.



**Measuring Paint Thickness on an Aircraft Skin Panel with a Boonton Gauge. The Meter is First Set to Zero with a Sample of the Same Alloy**

When a conductor with an organic finish is brought into the electrical field, eddy currents circulate through the conductor. These currents generate an electromagnetic field, which induces an electromotive force in the coil. This force opposes the original current and changes its impedance, and the change produces a reading on the meter.

The meter is first set to zero, with the probe resting on a sample of an alloy of the same composition as the work sheet. Calibrations of the meter indicate thickness of the paint in thousandths of an inch. The Boonton gauge is non-destructive, and can be used on any non-ferrous metal surface where there are no sharp irregularities of contour.

# Baldwin Automatic Control System for a Rolling Mill

The cold strip rolling mill shown in Fig. 1 is installed in the works of D. F. Tayler, Ltd., Carver Street, Birmingham, and has recently been equipped with the new nucleonic automatic gauge control system developed by Baldwin Instrument Co., Ltd., Brooklands Works, Dartford, Kent. It is stated that the mill is the first of its type in the country to be fitted with this equipment, which provides for automatic adjustment of the screw-down mechanism while rolling is in progress, so that strip is produced to a high degree of accuracy for thickness.

Intended for use on strip mills for the cold rolling of brass, copper and steel, the control system depends for its action on bremsstrahlung radiation, which is produced by the emission of beta rays from a radio-active strontium 90 source, on to a metal target. Whereas, with beta rays, steel strip with a maximum thickness of only about 0·02 in. can be measured, bremsstrahlung radiation, it is claimed, enables thicknesses ranging from approximately 0·004 to 0·4 in. to be checked.

Cast steel housings, for the radio-active source and the receiver unit, are mounted on a C-shaped bracket, which embraces the strip and is positioned between the rolls and the re-coiling reel. Part of this assembly may be seen in the close-up view Fig. 2, the detector unit being indicated at *A*. Of robust construction, the assembly is mounted on a substantial cross-slide, and may be moved to the working position, and withdrawn to the rear so that it is clear of the strip, by means of a Baldwin air cylinder. Electronic equipment incorporated in the measuring head is supported by anti-vibration mountings, and electric cables are housed in heavy-gauge copper tubing.

While gauging is in progress, radiation from the source is directed on to a sodium iodide crystal in the receiver head, and, in passing through the strip, its strength is reduced by an amount which depends upon the thickness. The reduced-strength radiation causes the crystal to scintillate, and the resulting light rays are passed to an adjacent photo-multiplier which generates an electric current proportional to their intensity. This current is fed to a separate floor-mounted control unit, and then is compared with a potential, which represents the required thickness of the strip and can be varied, as desired, by adjustment of a "set thickness" potentiometer. Any out-of-balance in this system causes a signal to be passed to a low-gain D.C. amplifier, which is connected electrically to the screw-down motors of the mill, by way of a discriminator unit and relays.

When the out-of-balance represents a deviation in the thickness of the strip from the

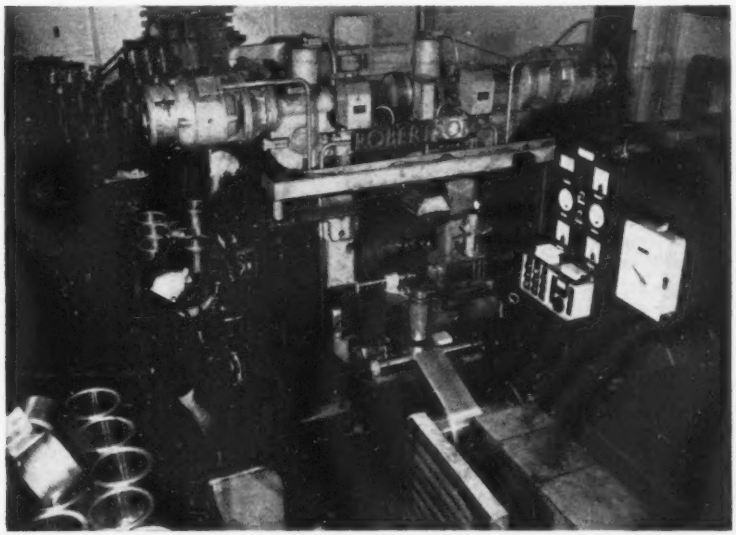


**Fig. 1. The Robertson Cold Strip Rolling Mill Here Shown is Fitted with the New Baldwin Nucleonic Gauge Control System**

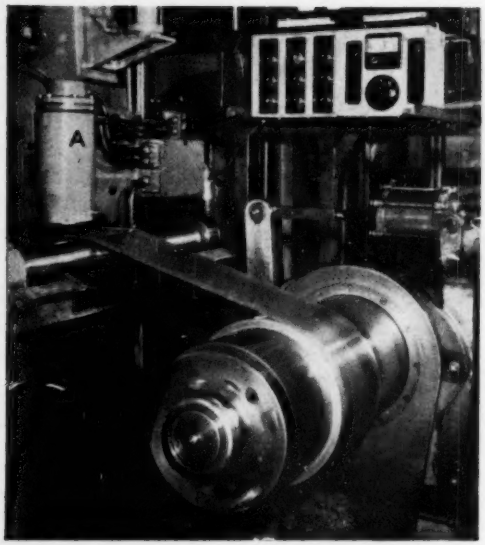



**Fig. 1. Close-up View Showing Part of the Measuring Head and the Indicator Panel**

nominal value of between ±0·0003 and ±0·0005 in., the discriminator unit causes the screw-down motors to be operated intermittently for a period of ¼ sec., at intervals of 2 sec. Signals resulting from deviations of strip thickness exceeding ±0·0005 in. cause the screw-down motors to be operated continuously for adjusting the roll setting. Alternatively, the equipment can be set so that intermittent and continuous adjustments of the screw-down mechanism are initiated when the thickness of the strip reaches tolerance boundaries different from those stated.

During the rolling operation, the thickness of the strip is continuously recorded on a paper chart by a pen mechanism incorporated in the control unit. The strip thickness in relation to the nominal value is also indicated on a dial-type meter. An indicator panel, mounted close to the rolling mill, incorporates signal lamps which are automatically illuminated when the screw-down motors are at rest, and when the roll is being adjusted upwards and downwards. A safety arrangement is provided which prevents the control system from being brought into use until the mill is running at a preset speed.

Upon completion of the rolling operation, a micro-switch is operated by the trailing end of the strip, and, then, the measuring head is moved clear on the cross slideway. Alternatively, cross-movement of the measuring head can be controlled by hand, through a solenoid-operated air valve. While the rolled strip is being removed from the take-up reel and a fresh coil is loaded in readiness for rolling, the control system is automatically calibrated. An indexing shutter incorporated in the source holder has three apertures, one of which is fitted with a 0·03-in. thick steel sheet, the second is closed by a thick piece of lead, and the third is blank. Indexing of the shutter is carried out automatically at the end of the rearward travel of the measuring head, and, by setting a selector switch, either the blank aperture or the steel sheet can be interposed between the radio-active source and the receiver head. Calibration of the instrument is carried out by means of the steel sheet when the thickness of the rolled strip ranges from 0·02 to 0·08 in., and the blank aperture is presented to the source when strip of thickness from 0·005 to 0·02 in. is to be produced. The lead reference piece is brought to the working position, by operation of a "manual standardize" switch, when the unit is to be calibrated at the infinity setting.

For calibrating purposes, current from the amplifier is applied to a second discriminator unit, which is connected to a servo-motor by way of relays. Operation of the servo-motor causes a potentiometer to be adjusted until a zero signal is received by the amplifier, from the photo-multiplier in the receiver head. The action of the discriminator causes the potentiometer to be adjusted intermittently for fine setting, and continuously when fairly large corrections are to be made.

Separate signal lamps are provided on the indicator panel, which are automatically illuminated, during, and at the end of, the calibrating operation, and when gauging of the strip is actually in progress. Other lamps show which reference piece is in use during the calibrating stage.

Built by W. H. A. Robertson & Co., Ltd., Bedford, the mill is of the 4-high, non-reversing type, and has 5¾-in. diameter by 18-in. wide, work rolls, and 15-in. diameter support rolls. It is employed for finish-rolling brass strip up to 15-in. wide, with thicknesses down to 0·004 in., at speeds up to 500 ft. per min. Drive to the work rolls is taken from a 100-h.p. mill motor. Of 12-in. diameter, the collapsible re-coiling reel is driven by a separate 15-h.p. D.C. motor, and an air-operated stripper mechanism is provided for unloading coiled stock at the end of the rolling operation.

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PRODUCTION OF DOMESTIC ELECTRIC WASHING MACHINES during the third quarter of 1957 totalled 170,400 units. During the corresponding period in 1956, 141,500 units were produced.

# Conference on Problems of Aircraft Production

The sixth Conference on Problems of Aircraft Production, organized by the Southampton Section of the Institution of Production Engineers, was held at the University of Southampton on January 2 and 3, with an attendance of about 250. The first contribution was the Lord Sempill paper, presented by Mr. Boyd K. Bucey of the Boeing Airplane Co., Ltd., Seattle, U.S.A., and entitled "Manufacturing in the Aeronautic Age." In the opening section of this paper, the author discussed the conditions facing the aircraft industry in the U.S.A., and the methods which were being adopted to overcome the difficulties associated, for example, with rapid technological advances, reductions in Government financial support, management in very large organizations, and complexity of designs, especially of weapon systems and test equipment. Among the methods mentioned were the adoption of quality control to replace inspection, by placing the responsibility for quality on all the employees of a plant, the system being extended even to the tool stores, since loss of tools had been found seriously to affect production schedules.

New production techniques, developed for the manufacture of aircraft and weapons to operate at increasing speeds, were then discussed, and many of them were illustrated in a colour, sound film, which was shown after the paper had been read.

Among the subjects touched upon was the friction sawing of titanium and stainless steel, and mention was made of a skin saw in the form of a 6-in. disc, with two carbide blades, which was run at 10,000 r.p.m., and would cut aluminium up to 1 in. thick. Improved results had been obtained in blanking sheet material, it was stated, by using a steel punch, produced by a patented method, in conjunction with a die of the steel rule type, and with this arrangement, upwards of 100,000 parts had been blanked from ¼-in. material with a single tool. Machining of heavy-gauge stainless steel and titanium was carried out with a contouring machine equipped with a tool of about 1 in. diameter (with inserted carbide blades) which projected vertically from the surface of the machine table. Speeds of 1,600 and 800 ft. per min. were quoted for stainless steel and titanium respectively, and liquid carbon dioxide was applied to the cutter for cooling purposes.

Other operations illustrated in the film, which ran for about 20 min., included, for example, those involved in the manufacture of a double panel from two stainless steel skins with X-section stiffeners between them. Extensions of each limb of the X were spot-welded to the top and bottom skins on a special machine, with the aid of a support mechanism which could be expanded for the welding operation, and then contracted to permit of indexing of the assembly. Fusion-type machines for welding sheet titanium, in which a trailing shield of gas is applied to both sides of the material, were also shown.

Attention was drawn to the use of heat in forming metals for which conventional methods were not suitable, and the film illustrated a Yoder roll-forming machine for sections, and stretch-forming machines for sheet and sections, on which the material was heated to between 1,000 and 1,500 deg. F. (for titanium) by means of gas furnaces and electrical heating elements. An interesting application of hot working, mentioned in the paper, was the upsetting of titanium rivets on a squeezing machine controlled by the yielding of the heated rivet. Titanium alloy sheet could be formed by heating it, with a simple blow-torch set-up, while it is in position over the punch. A drop hammer, fitted with a rubber pad, was then employed to form the sheet round the punch, the rubber being confined in a recess in the tup, and being in contact with the hot sheet for such a short time that it is not adversely affected.

Other subjects mentioned in the paper included forgings, integrally-stiffened skin panels, super high strength steels, chemical milling, the standardization of machine tools, and numerical control. Improved techniques for forming, in addition to others already mentioned, included those involving the use of explosives, flow-turning, and shot peening. A new method of making radomes, whereby layers of resin-impregnated glass fibre material were wrapped round a tapered mandrel in the circumferential and longitudinal directions alternately, was said to give very consistent electrical properties, and to enable the production time to be considerably reduced.

Abstracts from the paper entitled "Manufacturing Practice—A Review of the British Aircraft Industry," presented by Mr. L. G. Burnard, M.I.Prod.E., A.F.R.Ae.S., Vickers-Armstrongs (Air-

craft), Ltd., were published in MACHINERY, 92/37—3/1/58 and 92/97—10/1/58, and references to this paper during the discussion at the end of the Conference will be given later. Instead of reading his rather long paper, Mr. Burnard showed an interesting silent film, in black and white, of some of the machines described in it, including routing machines for the production of ribbed skin panels and other components, and the procedure for making ribbed panels by chemical erosion. Equipment for the programme control of machine tools, and machines for accurately bending aircraft pipes, were also shown in operation.

Subsequently, a colour, sound film made by the Fairey Aviation Co., Ltd., was shown. Running for about 10 min., this film was concerned with the 3-dimensional sculpture-milling machine built by the company, to which some reference was made at the Fourth Conference, two years ago. This machine incorporates the Ferranti system of magnetic tape control, and will accommodate stretched aluminium slabs measuring up to 27 ft. long by 7 ft. wide. We hope to describe the Fairey machine in detail in a future issue of MACHINERY.

The paper entitled "Some Aspects of the Design, Development and Manufacture of the P.1 Wing," which was presented jointly by Mr. F. Bradford, A.F.R.Ae.S., and Mr. G. H. Taylor, who are concerned with design and production, respectively, for the English Electric Co., Ltd., was restricted in its scope by security considerations, but was of considerable interest to aircraft designers and production engineers. The wing was designed for production in two halves, each of which comprised an upper and a lower portion. These two portions were made separately, and was then assembled into a complete structure which incorporated fuel tanks and other features. Sealing of the fuel tanks, of which the wing skin panels form the sides, presented difficulties, and various methods were tried. One of these methods, for sealing 3-corner joints, involved the use of a rubber block, cured to the required contours in a mock-up joint which served as a die, and then bolted into the corner. Compression of the rubber block, by the fixing bolt, forced the material into close contact with the joint surfaces in the final assembly, which was thus rendered completely leak-proof.

Rivets for the attachment of the skin panels were made leak-tight by machining a ridge, of 90-deg. section, in the countersink surface. When the rivet was upset, this ridge bit into the rivet head, and a joint with the required characteristics was obtained. For a bolt, the ridge was machined on the conical surface of the head, so that, when tightening took place, the ridge bit into the skin material. Joints made with these bolts and rivets were found to be satisfactory under pressure, even without the use of conventional sealants.

Among the production methods considered in the part of the paper contributed by Mr. Taylor were those concerned with the forming of T-section extrusions to various angles for spar booms, and reference was made to an extrusion of special design from which these booms could be produced more readily. Booms were formed to fit the wing skin panels on a Hufford A.46 machine (Wickman, Ltd.), and drilling and reaming of the skin panels, booms and other components, performed with the aid of fixtures, was followed by riveting on a special machine. Among the wing components which were produced by machining methods, was a frame with a double curvature, which was now being made from a precision die pressing supplied by High Duty Alloys, Ltd. This pressing was made to limits of $-0{\cdot}000/-0{\cdot}030$ in. over its length of about 30 in. Another interesting component mentioned was a steel bearing housing made from DTD 124 and S 92 material, which was fabricated by welding, and subsequently heat-treated to provide a tensile strength of 45 to 50 tons per sq. in.

## APPLICATIONS OF NUMERICAL CONTROL

The discussion which followed each paper was somewhat limited, but a longer period was provided after the third paper, during which questions could be addressed to any speaker, and those attending the conference were invited to make their own contributions, where they had any special knowledge of the subject raised. Among the matters discussed was the design of a capstan lathe mentioned by Mr. Burnard, which would be capable of setting itself from numerical information supplied in the form of a punched tape or card. As outlined, the lathe, arranged for bar feed, would be so equipped that the cutting tool, on passing a datum point, would register its position. The tool would then be controlled numerically and would be fed into the required depth, after which it would be traversed longitudinally according to the shape of the component required. By controlling the bar feed, and the tool slides and capstan head, it would be possible, theoretically, to prepare the lathe merely by clamping tools in position without setting, and to insert the punched tape or card, whereupon the machine would produce a number of components and stop.

In reply to subsequent questions, Mr. Burnard said that where quantities as small as 10 were concerned, as often happened in the aircraft

industry, it might take, say, 1¾ hours to set the machine and 20 min. to make the parts. Progress which had been made so far had shown that it would be possible to control one slide in the manner indicated, and it was now intended to apply the system to the remainder of the machine.

Another application of numerical control, which was also in its early stages of development, was for the production of aircraft tubing in which complicated and accurate bends were required. The machines described in Mr. Burnard's paper would lend themselves to numerical control, and work was proceeding in this connection. The production of integrally-stiffened skin panels, and other intricately-shaped parts, was being undertaken in this country largely by high-speed routing techniques, as described in Mr. Burnard's paper, and such methods were now being applied to high-tensile steel components, of which two examples were on view. These parts had been machined by the routing technique, at cutting speeds of 700 to 800 ft. per min., as compared with speeds up to 10,000 ft. per min. for light alloys, by Ferrand Luttmer, Ltd., London, with a tool of special design and liquid carbon dioxide cooling.

One of the examples shown was for the Gloster Aircraft Co., Ltd., and had been finished on the outer profile in a time of 1 hour 20 min. This component was of S.99 steel, and had been machined with a cutter tipped with Prolite 14 carbide, running at 4,000 r.p.m., and cooled by carbon dioxide at the rate of 20 lb. per hour. One such component could be finish-machined, and another rough-machined, for each regrind of the cutter. In the other, smaller part, a pocket had been machined by the routing technique.

## TITANIUM

In connection with titanium, perhaps the most interesting point to emerge from the discussion was the statement by Mr. W. S. Hollis, of the Ministry of Supply, that the material now cost £6 per lb. in the raw state and between £22 and £30 per lb. of installed weight in an aircraft. Mr. Hollis also mentioned that, whereas tool lives of 30 to 40 sec. were common in the early days of machining titanium, they had now been extended to as much as 20 min. Both forming and resistance welding were being carried out satisfactorily. Mr. Taylor, of the English Electric Co., Ltd., said that his company had been machining C130AM titanium with carbide tools, which could be used for periods up to 4 hours without re-grinding, at a cutting speed of 180 ft. per min. It was advisable, he said, to produce blanks for small forgings by machining from the bar, rather than by upsetting methods, since the latter rendered the material almost unmachinable. Scalping between heats might also be carried out with advantage.

Mr. J. Purcell, of the College of Aeronautics, Cranfield, described some experimental work in which it had been found that build-up of titanium took place on the cutting edge of a tool, and if it was removed, some of the tool material was carried away. If the build up was allowed to take place at a slow cutting speed, of the order of 50 ft. per min., a protective shield of titanium was formed on the cutting edge and the speed could then be increased by as much as five times, while still obtaining reasonable tool life. In answer to Mr. Burnard's suggestion that a chemical coolant should prevent pressure welding, and consequent build up, Mr. Purcell said that it was difficult to maintain a film between the tool edge and the component face.

## MIST LUBRICATION FOR CUTTING TOOLS

Mist lubrication of cutting tools was also discussed at length, following a description of the system by Mr. Burnard, in which he mentioned the machining of light alloys with carbide cutters. These cutters originally had a life of one or two days between regrinds, but with mist cooling they lasted for a week or more. On this subject, Mr. A. E. N. Bolton, of Sperry Gyroscope Co., Ltd., reported that slots, $\frac{1}{16}$ in. wide and up to ⅜ in. deep, were being milled in forged steel, of 65 tons tensile strength, with a solid carbide cutter, which was run at 30,000 r.p.m. The best results had been obtained with DTD 585, a hydraulic fluid based on paraffin, which had enabled cutter life to be increased by 50 to 60 per cent.

Mr. J. Glennie of Bristol Aircraft, Ltd., asked Mr. Burnard whether the use of mist coolants might not be undesirable for health reasons, and the answer was that less than a pint per day per cutter was employed and was delivered through a very small jet. On reaching any metal parts of the machine, the jet was converted into a liquid which ran away, so that there was very little mist in the air breathed by the operator.

Mr. Bolton said that owing to discomfort experienced by operators on machines adjacent to those equipped for mist cooling, his company had fitted vacuum extraction nozzles on the opposite sides of the cutters to the mist jets, to take away overspray. For one operation, more than ½ gal. per day was being used. Mr. Burnard remarked that only the minimum of spray needed to form a coating on the cutter, to provide lubrication and prevent pick-up and consequent smearing of the machined face, was employed. It was suggested by Mr. Bolton, however, that any reduction in the

amount of coolant applied would result in shorter cutter life, and extractors had therefore been fitted. Mr. Purcell described an apparatus for measuring the amount of coolant that would be breathed in by an operator.

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On the subject of standardization of design, Mr. Bucey commented that, at one time, it had been the practice of the Boeing Co. to place in a book a drawing of any clip or bracket which might be useful in another application. Eventually the number of books became so large that no one would consult them. It was now found to be quicker to design another component than to search for an existing design. Among the items that were standardized were bolts, screw and flange holes, tools, tube-bend radii and milling cutter sizes. Pulley brackets were normally made from standardized double extrusion material.

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MINIATURE BEARINGS, LTD., 39 Parliament Street, Westminster, London, S.W.1.—Catalogue of RMB miniature bearings made by Roulements Miniatures S.A., Bienne, Switzerland. Information is included on load capacity, friction torque, inspection tolerances, mounting and mounting fits, cleaning, lubrication, and angular contact. The various types of bearings are illustrated and particulars of the available sizes are conveniently tabulated. In addition details are appended of three new series of inch size bearings which are now in production or preparation. The agents point out that since the 1954 catalogue was issued, the production of Series E, O, and OT bearings has been discontinued. These bearings, however, will still be supplied until stocks are exhausted. A new series of NUS roller bearings has been introduced, which are similar to the NU series, but without inner races.

# "National" Machines to be Built in this Country

Arrangements have recently been concluded whereby a range of forging, cold heading and precision nut tapping machines, also Reduceroll roll forging machines and Maxipres forging presses, developed by the National Machinery Co., Tiffin, Ohio, U.S.A., will be built under licence by W. H. A. Robertson & Co., Ltd., Bedford. Sales and service of the British-built machines will be handled by Buck & Hickman, Ltd., Otterspool Way, By-Pass, Watford, who will continue to distribute National machines made in the U.S.A.

Production of high-speed nut tapping machines has already started in this country, and delivery is expected to begin in about 6 to 8 months' time. It is anticipated that the full range of British-built National machines of different types and sizes will be available within the next two years.

The tapping machines, an example of which is shown in Fig. 1, are being made in four sizes with capacities for handling hexagon nuts of ¼, ⅜, ½ and ¾ in. sizes. Of the non-reversing type, these


**Fig. 1. An Example from the Range of National High-speed Nut Tapping Machines**

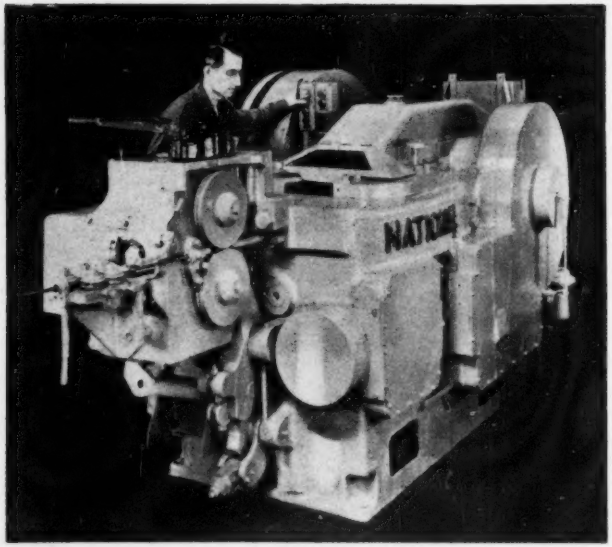


**Fig. 2. National ⅜-in. Capacity Double-stroke Cold Heading Machine**

machines are fully automatic in operation, and incorporate a number of advanced design features which enable accurate threads to be cut at high speeds. Bent-shank taps of a special design are employed, and a pitch control system is incorporated. Other features include safety stopping devices and a sorting unit. As an indication of the production rates obtainable, it may be noted that the smallest machine will handle 96 nuts with ANC threads or 72 nuts with ANF threads per min.

Solid die cold heading machines will be available in single and double stroke designs, and will include tubular, ball, and roller headers. Initially, the machines will be built in five sizes for handling stock of ⅜, $\frac{3}{16}$, ¼, $\frac{5}{16}$ and ⅜ in. diameter, although the range will be extended later to

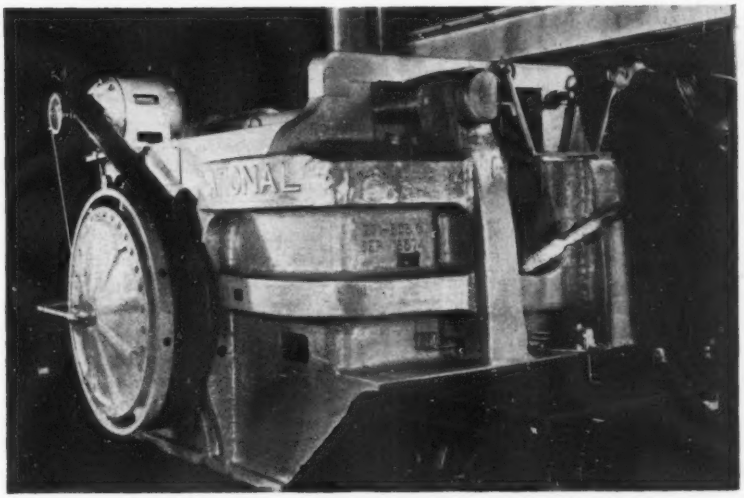


Fig. 3. National 4-in. Capacity High Duty Forging Machine

include headers up to ¾ in. capacity. The double-stroke cold heading machine shown in Fig. 2, is intended for the production of machine bolts, carriage bolts and cap screws, for example, with shank diameters up to ¾ in. It incorporates recently-developed cut-off and transfer units and a new oscillating tool holder and dynamic counterbalance system which permit increased operating speeds. A new workpiece ejector is also fitted which ensures improved die life. The all-steel box-type bed is of exceptional strength to provide the necessary rigidity, and all moving parts are enclosed.

The machine will produce bolt blanks at the rate of 135 per min., and on the single-stroke header of similar capacity, the output rate is 160 blanks per min. On the ¼, $\frac{3}{16}$, ¼ and $\frac{5}{16}$-in. double stroke machines bolt blanks can be produced at rates of 250, 225, 200 and 175 per min. respectively. The corresponding figures for the single-stroke machines are 400, 330, 275 and 225.

National high-duty forging machines will be built with capacities for handling bar stock of 1, 1½, 2, 2½, 3, 4, 5 and 6 in. diameter, and operating speeds ranging from 90 to 27 strokes per min. In Fig. 3 is shown the 4-in. capacity forging machine which has a working speed of 35 strokes per min. This machine has a short compact bed, and a long overarm heading slide which ensures accurate alignment of the punch and die. Other design features include a suspended gripper slide and an air-operated clutch with friction slip relief.

The Reduceroll roll-type forging machines will handle bar stock of circular or square cross section, and are specially designed for pre-forming blanks that are to be subsequently formed to the desired shape in a forging press. The machines enable blanks of uniform shape to be readily prepared, and the subsequent press-forming operation can usually be performed without re-heating the work. These machines will be built in 6 sizes which are designated No. 1, 2, 4, 6, 7½ and 10.

Maxipres high-speed forging presses are to be made in 5 sizes with capacities of 700, 1,300, 1,600, 2,000 and 2,500 tons. These presses have operating speeds of 90, 80, 70, 60 and 55 strokes per min., and ram travels of 8, 10, 11, 12 and 14 in. In Fig. 4 are shown, the Maxipres 700 ton press and the No. 4 size Reduceroll roll forging machine, set up for the production of wrenches.

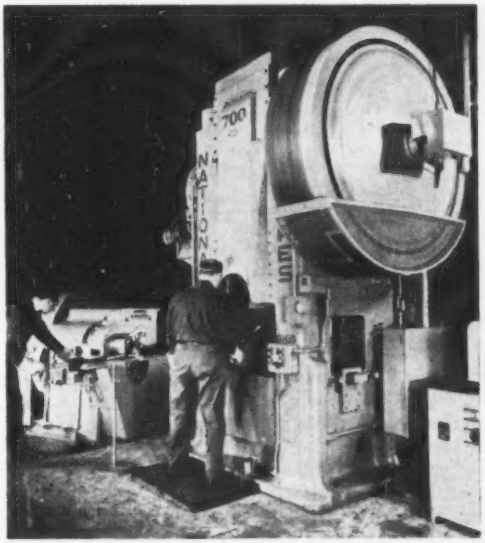



Fig. 4. A Maxipres 700-ton Forging Press and a No. 4 Size Reduceroll Roll Forging Machine

# News of the Industry

## Yorkshire

GREENWOOD & BATLEY, LTD., Armley Road, Leeds, are experiencing a well-maintained demand for their various products. Standard-type cold heading machines of various sizes are in hand, also the high-speed, solid die, double-blow machines, up to ¾-in. capacity. In addition, we may note orders for thread rolling machines, bolt head trimming presses, and screw nicking machines. Friction screw presses are another active line, and recent orders cover machines with capacities of 20, 125, 450 and 1,000 tons. Horizontal hot forging machines, for 1- and 1½-in. diameter bars, are also being built. Special equipment on order includes single- and double-spindle vertical profile milling machines; vertical double-action punching and cupping presses for cap shells, with double feed rolls and transfer mechanism; and horizontal, multiple-operation, toggle-type drawing machines with hopper feed. We may note recent export business with Canada, Australia, India, and Pakistan.

Greenbat fixed and elevating platform electric trucks, including fork-lift types, are in brisk demand, and a good business is reported in mining locomotives. Our attention was drawn to a 10-ton fixed platform electric truck with power-assisted steering, which has been built for the Atomic Energy Commission; and to a 5-ton, elevating-platform truck, with a hopper mounted on the platform, for carrying aluminium powder, which is blown from the hopper into the furnace. The latter vehicle is destined for an aluminium plant in Canada. We hope to make further reference to both these trucks in due course. We may note a recent order from the National Coal Board for a 14-ton battery locomotive of 90 h.p.

HAYES ENGINEERS (LEEDS), LTD., Gelderd Road, Leeds, inform us that there is a sustained demand for their Diemaster and Tracemaster precision vertical milling machines, some of which are being equipped with Hydrotracer hydraulic copying equipment, and jig boring and high-speed milling attachments. Recent developments include a fully-automatic machine for 3-dimensional copy machining of solid rotor blades; an automatic machine for sinking square cavities in turbine blades, and a special, twin rotary table, cam milling, machine. We hope to make further reference to these special machines at a later date. Tracer valves, hydraulic pump units, and hydraulic profiling equipment for application to machine tools are in good request.

In the machine tool sub-contract section we noted a number of automatic tool and cutter grinding machines and die-casting machines in progress. Recent plant additions include a large Coventry thread-grinding machine, and Precimax 6- by 12-in. plain and 10- by 20-in. universal grinding machines. The firm's slideway grinding capacity has been doubled by the conversion of a planing machine for slideway grinding, by the application of a universal grinding head to the cross-slide and hydraulic transmission to the table.

MIDGLEY & SUTCLIFFE, LTD., Hunslet, Leeds, report a steady influx of orders for their various types of plain and universal horizontal and vertical milling machines, also for radial drilling machines up to 6 ft. radius. A new size of vertical milling machine, in course of development, will have a 48- by 11-in. table. This machine incorporates the table and knee of the latest No. 3 size plain or universal horizontal milling machine. We may also note that orders are in hand for turret-head type milling machines. Among plant recently installed we noted a Herbert No. 7 Preoptive turret lathe, an Abwood circular dividing machine, and a Herbert broaching machine.

CAMPBELLS & HUNTER, LTD., Sayner Road, Leeds, have some capacity available for cutting spur gears up to 8 ft. 6 in. diameter, and bevel gears up to 3 ft. diameter. Gears can be supplied complete or machined from customers' blanks.

SAMUEL DENISON & SON, LTD., Hunslet Foundry, Leeds, are well placed for orders for testing machines and weighing equipment from both home and overseas customers. On the testing machine side, in addition to standard-type dial machines, of various capacities, we may note creep testing machines and special-purpose types. Orders are also in hand for various sizes of weighbridges and for conveyor-type weighers.

FRANK WIGGLESWORTH & CO., LTD., Saltaire, Shipley, have supplied a leaflet describing their Texrope grommet V-belts, a development which has resulted from co-operative research by the Allis-Chalmers and B. F. Goodrich companies. Compared with normal V-belts, the grommet type is claimed to have from 20 to 50 per cent longer life, with cooler running, increased shock absorb-

ing capacity, much lower shrinkage and stretch, improved grip, and 20 per cent greater tensile strength.

TEXTILE MACHINERY CONTRACTS, valued at more than £700,000, were concluded with British firms by the Chinese textile machinery mission before they left Britain at the end of last year, according to the *China Trade and Economic Newsletter*. Deliveries are to begin in March and are to be completed before the end of 1958.

PRIESTMAN BROTHERS, LTD., Hull, have applied ten grabs for Colvilles' new ore discharging installation at the deep water berthage at General Terminus Quay, Glasgow. Four are of 170 cu. ft., four of 140 cu. ft., and two of 70 cu. ft., 4-rope Trojan type. Two "Cob" Mark V excavators, fitted with scraper plates to clear the ore into the squares of the hatches, were also supplied for work inside the ships' holds.

H. B.

## Coming Events

INSTITUTION OF MECHANICAL ENGINEERS.—*Applied Mechanics Group.* January 22, at 6.45 p.m., at the Institution, 1 Birdcage Walk, London, S.W.1; discussion on "The Measurement of Noise and Vibration." *General Meeting.* January 24, at 4.30 p.m., at the Institution; paper on "The Management Control of Small Engineering Firms," by L. Fontaine, M.Sc., J. W. Walker, B.Sc. (Eng.); and W. R. Spencer.

INSTITUTE OF METAL FINISHING.—*South-West Branch.* January 21, at 6.30 for 7 p.m., at the Grand Hotel, Bristol; paper on "Hard Chromium Plating of Gun Barrels," by R. A. F. Hammond.

INSTITUTION OF ELECTRICAL ENGINEERS.—*South-Western Sub-centre.* January 23, at 3 p.m., at the Electricity Showrooms, Bedford Street, Exeter; paper on "Safety in the Use of Portable and Transportable Electrical Equipment in Industry," by J. W. Bunting.

INSTITUTION OF PRODUCTION ENGINEERS.—*Tees-side Section.* January 21, at 7 p.m., at the College of Further Education, Cleveland Avenue, Darlington; lecture on "Nuclear Power and its Effect on the Production Engineer," by I. Munro, B.Sc. *Derby Section.* January 24, at 7 p.m., at the College of Art, Derby; lecture on "We Build the Jig Mill," by S. C. Fenton. *Manchester Section.* January 27, at 7.15 p.m., at the Reynolds Hall, Manchester College of Science and Technology, Sackville Street, Manchester; lecture on "Plastics Material in Engineering," by A. P. Clark. *Stoke-on-Trent Section.* January 27, at 7.30 p.m., at the Grand Hotel, Hanley, Stoke-on-Trent; lecture on "Nuclear Power and its Effect on the Production Engineer," by I. Munro, B.Sc. *Oxford Section.* January 21, at 7.30 p.m., at S. Smith & Sons, Witney Airfield, Witney, Oxon.; lecture on "Copy-turning and Its Development," by a representative of Vaughan Associates, Ltd. A film will also be shown.

## Melting Furnace Film

A 16-mm. sound film, concerned with the 6-cwt. capacity carbon-rod resistor furnace which is installed at the experimental foundry of the British Steel Castings Research Association, East Bank Road, Sheffield, 2, has been made by the Association's own film unit. Originally produced to illustrate the inaugural lecture of the recently announced exchange series between the B.S.C.R.A. and the Steel Founders' Society of America, this 15-min. film describes in detail the construction and operation of this steelmaking furnace which was the first of its type to be ordered for installation in this country. The film is available to non-members of the Association on payment of a hire charge of £5 5s. 0d., and application should be made to the Secretary of the Association at the above address.

## Productivity Council Conferences

The British Productivity Council, North London Productivity Committee, has arranged the following conferences which will be held in the Council Chamber, Federation of British Industries, 21 Tothill Street, London, S.W.1.

Production Control, March 13. Subjects to be discussed include reduction of variety; streamlining small quantity, complex production; flow production; and computers in the service of production.

Work Study—the Universal Load, May 15. Aspects considered will include method study; organization and methods; fatigue study; work measurement; time study; analytical estimating; memo motion analysis; and predetermined motion line systems.

Further particulars may be obtained from the Hon. Secretary, Mr. Charles Cooper, M.I.Prod.E., A.M.I.I.A., 126 The Ridgeway, Enfield, Middlesex.

## Women in Engineering

(*Continued from page* 119)

portion of women among students of technical subjects is estimated to be less than 1 per cent. For comparison, it may be noted that in the U.S.S.R. about 50 per cent of the students of engineering and technological subjects are women. While it is not suggested that we should emulate everything that is Russian, it does appear that the intake of women into our engineering and allied professions is disproportionately small. The handful of women engineers who have already achieved professional status in this country, and who are working as planning engineers, designers, aero-dynamicists, and development engineers, for example, have demonstrated that, given the requisite training, women can contribute as much as men to output and efficiency. Increasing facilities should be provided, therefore, for young women of ability and initiative to enter the engineering and allied professions, and they should be given every encouragement to play a fuller part in our industrial life than hitherto.

# Industrial Notes

THE PULSOMETER GROUP inform us that their London office is now at Pulsometer House, 20-26 Lamb's Conduit Street, W.C.1. Telephone number, Holborn 1402.

G.A. PRECISION PRODUCTS, LTD.—The address of this company is now No. 2 Factory, Darkes Lane, Potters Bar, Middlesex (telephone number, Potters Bar 6895).

B.E.L.A. MACHINE TOOLS, LTD.—The head office of this company is now at Burton Chambers, Church Alley/Church Street, Liverpool, 1 (telephone number, Royal 7443: telegraphic address, Belaliv, Liverpool, 1).

WESTOOL, LTD., St. Helen's Auckland, Co. Durham, have begun publication of a house journal entitled "Expansion." The first issue includes an article on D.C. solenoid design, and notes on the new Westool factory.

THE 1958 ELECTRICAL ENGINEERS EXHIBITION will be held at Earls Court, London, from March 25 to 29. It will occupy an area of 450,000 sq. ft., and there will be approximately 400 exhibitors.

STANLEY WORKS (GREAT BRITAIN), LTD., Rutland Road, Sheffield, 3, have introduced a range of masonry drills with tungsten carbide tips in sizes from No. 3 to No. 30L. A resharpening service for these drills is maintained.

HIGH SPEED STEEL ALLOYS, LTD., Widnes, Lancashire.—A recent issue of the *Alloy Metals Review*, published by the company, contains an informative article on "molybdenum for high strength at high temperatures."

M. C. LAYTON, LTD., who have been established for 21 years, have opened a branch office at 23 Newton Street, Birmingham, 4, which is under the direct control of Mr. Layton. Mr. R. Mitchell and Mr. D. Warren have been appointed as additional representatives.

THE INDUSTRIAL WELFARE SOCIETY (INC.), Robert Hyde House, 48 Bryanston Square, London, W.1, are holding a conference at Brighton from January 24 to 27. At this conference, foremen and managers—attending in equal numbers—will consider problems of mutual importance.

PERMALI, LTD.—The address of the London office of this company, and of the associated companies, Hordern Richmond, Ltd., and Hydulignum-Jabroc (Tools), Ltd., is now 39 Victoria Street, S.W.1. The telephone number (Abbey 6494) has not been changed.

THE BRITISH MOTOR CORPORATION, LTD., Longbridge, Birmingham, report a production of nearly 450,000 vehicles in 1957, which represented an increase of 33⅓ per cent as compared with the 1956 total. Of last year's output, nearly 220,000 vehicles were exported, with a value, including service parts, of almost £100 million.

AN AUCTION SALE OF MACHINE TOOLS, clothing and miscellaneous stores from M.O.S. Sub Depot, Lily Lane, Byley, Middlewich, Cheshire, will be held at New Islington Public Hall, Ancoats, Manchester, on January 28 and 29. The auctioneers will be J. H. Norris & Son (Dept. N), Albert Square, Manchester, 2.

THE DIAMOND SCREW & COTTER CO., LTD., Cherrywood Road, Bordesley Green, Birmingham, 9, recently celebrated the 50th anniversary of the establishment of the business. A jubilee folder, which has been issued, shows typical products including high tensile bolts and studs, gear levers and tapered parts, brass turned parts and inserts, and valve bodies and parts.

THE PROFESSIONAL AND EXECUTIVE REGISTER of the Ministry of Labour and National Service is now at City of London Employment Exchange, Atlantic House, Farringdon Street, E.C.4 (telephone number, City 5020). The register is intended not only to assist employers in filling senior executive and management posts, but also to help them in recruiting trainees for executive positions.

THE YORKSHIRE COPPER WORKS, LTD., Leeds, report that the negotiations for a merger of the business with the corresponding section of the METALS DIVISION of IMPERIAL CHEMICAL INDUSTRIES, LTD., have now been virtually completed, and the proposals will be submitted to shareholders for approval at an extraordinary general meeting on January 27.

EMPLOYMENT IN MANUFACTURING INDUSTRIES.—In October the number of persons employed in manufacturing industries rose by 20,000 from 9,217,000 to 9,237,000. In "engineering, metal goods and precision instruments" there was an increase of 7,000, in "vehicles" an increase of 3,000, and in "metal manufacture" an increase of 1,000.

LEEMANS BROS. (PTY.), LTD., Metal Lane (Bottom of Kloof Street), Cape Town, are interested in manufacturing, under licence, metal products for household, agricultural, and industrial purposes. They state that they have well equipped press and machine shops and tool-room. They would also consider the production and marketing, locally, of injection moulded plastics items.

AVONMOUTH ENGINEERING SERVICE, LTD., St. Andrews Road, Avonmouth, Bristol, are engaged in the construction of large steel structures and pressure vessels for oil refineries and chemical works. Since this company was formed ten years ago its activities have been expanded to embrace the production of component parts for a wide range of assemblies used in the construction of conveyors and elevators for handling various materials. The facilities include a well-equipped machine shop.

AN ULTRAPHOT II AUTOMATIC CAMERA MICROSCOPE, stated to be the first to reach this country, was recently delivered to Standard Telecommunication Laboratories, Ltd., Dowlish Ford Mills, Ilminster, Somerset. Made by Carl Zeiss, Oberkochen (Degenhardt & Co., Ltd., 32 Maddox Street, London, W.1), the camera has fully automatic exposure adjusting mechanism. It can be used for visual observations and microprojection, as well as for photo-micrography.

THE BRITISH ALUMINIUM CO., LTD., have recently put into operation, at their Falkirk works, a large integrated plant for the production of corrugated aluminium sheet from coiled strip. This plant will produce sheets up to 35 ft. long with thicknesses from 0·028 to 0·064 in. The economic advantages of long sheets are considerable, since the number of laps in a given roof area can be reduced with a consequent saving in material, and in handling and fixing costs.

INDUSTRIAL WELFARE SOCIETY, Robert Hyde House, 48 Bryanston Square, London, W.1. A week-end conference for foremen and shop stewards with the theme Conflict or Co-operation will be held from February 28 to March 3 at the Hotel Majestic, St. Annes-on-Sea. A course for junior executives and management trainees on the subject of Production through People will be held from March 3 to 7 at Robert Hyde House, London. Full particulars can be obtained from Mrs. O. K. Shelley, Administrative Officer, at the above address.

THE BRITISH INSTITUTE OF MANAGEMENT, Management House, 80 Fetter Lane, London, E.C.4, is organizing a 2-day course on "the art of selling" for salesmen and sales managers. It will be held at Caxton Hall, London, on March 13 and 14, and will be conducted by Mr. Heinz M. Goldmann, a leading European consultant in sales training. This course, it is suggested, will afford businessmen an opportunity of "preparing for the competitive atmosphere of the European common market and free trade area."

KAYSER, ELLISON & CO., LTD., are to open a new warehouse next month at Station Road, Coleshill (telephone number, Coleshill 2041-2). This warehouse will have an area of more than 3,000 sq. ft. with overhead crane facilities throughout, and will be insulated and centrally heated to provide conditions suitable for the storage of centreless ground as well as black bars. Initially the stock will comprise a range of the company's well known K.E. steels suitable for such applications as blanking and other press tools, gauges, die casting dies, plastics moulds, cold heading dies, punches, ejector pins, drill bushes and dowels, also tool bits.

THE INTERNATIONAL INSTRUMENT SHOW to be held at Caxton Hall during the week commencing March 24 will be nearly 30 per cent larger in floor area than the 1957 exhibition, and will occupy the Great Hall and Court Room.

It is expected that more than 60 firms from 10 countries will participate. Normal day opening hours will be from 10.30 a.m. to 6.30 p.m., but to facilitate the attendance of parties of students and apprentices, the Show will remain open until 9 p.m. on March 26, and until 12 noon on March 29. Tickets are available on request from the sponsors, B. & K. Laboratories, Ltd., 57 Union Street, London, S.E.1.

CANADIAN BRITISH ALUMINIUM CO.—It is reported that, less than 20 months after work began on clearing the site, the first metal was poured recently at the new aluminium smelting plant of the company at Baie Comeau in the Province of Quebec on the north shore of the St. Lawrence River, 400 miles north-east of Montreal. This company is a subsidiary of the British Aluminium Co., Ltd., and was formed in partnership with the Quebec North Shore Paper Co.

The event marked the completion of the first of four production stages for the £50 million plant which will eventually have an annual capacity of 160,000 long tons of virgin aluminium ingot. It may be noted that this ultimate capacity represents two-thirds of the present annual consumption of virgin aluminium ingot in the United Kingdom.

THE IRON AND STEEL BOARD reports that steel production in 1957 is expected to have reached about 21·7 million tons compared with the estimate of 22·3 million tons for possible production made at the beginning of the year. The output should, however, be a million tons greater than in 1956.

The shortfall of 600,000 tons on the estimate is attributed to a drop in the demand for tinplate; running down of stocks; delay in bringing new finishing equipment into operation; and the strike in the engineering industry in the spring. There has also been a tendency for consumers, particularly of light sections, to reduce their commitments, possibly because of the higher interest rates now ruling.

Steel production in November averaged 429,200 tons a week, compared with 437,800 tons in October, and 426,400 tons in November, 1956. For the first 11 months of the year, production was 5·4 per cent above that of the corresponding period of 1956. Pig iron production in November was at the rate of 281,500 tons a week, as against 285,500 tons in October, and 262,700 tons in November, 1956.

## Personal

MR. A. V. TIDDY, assistant secretary of Samuel Osborn & Co., Ltd., Clyde Steel Works, Sheffield, 3, has been appointed a local director of the company.

MR. K. L. STRETCH has been appointed director of the Central Engineering Establishment of the National Coal Board at Bretby, South Derbyshire. He was formerly deputy director of the Establishment and has been acting director since the death of Mr. L. H. Daniel in September.

DR. A. D. MERRIMAN, G.C., O.B.E., D.L., M.A., M.Ed., D.Sc., C.I.Mech.E., F.R.S.E., formerly secretary of the Institution of Metallurgists, has been appointed by Edgar Allen & Co., Ltd., Imperial Steel Works, Sheffield, 9, as consultant on scientific projects.

MR. W. FORD, since 1951 a sales engineer at the Swansea office of Brook Motors, Ltd., Empress Works, Huddersfield, has been transferred to the Birmingham office to succeed MR. H. C. CURTIS, who has left the company to take up an appointment abroad.

MR. D. J. GUILD, A.M.I.B.F., has recently joined the staff of Armstrong Whitworth (Metal Industries), Ltd., Gateshead, and Jarrow Metal Industries, Ltd., Jarrow, as technical representative in the Midlands area, under the Midlands manager, Mr. J. Bell, Somerset House, Temple Street, Birmingham.

MR. A. P. GIBBS, hitherto North West area manager for Ransome & Marles Bearing Co., Ltd., Newark-on-Trent, has taken up an appointment at the company's head office. MR. H. V. WILLDER is now manager of the Manchester office assisted by MR. E. L. PATON, and MR. G. H. WALKER, formerly stores supervisor, is Liverpool sub-office manager.

MR. G. H. BUCHANAN, who for the past 14 years has been the representative in Scotland for Craven Brothers (Manchester), Ltd., Stockport, retired recently. He has been succeeded by MR. H. PROBERT, who will also be in charge of the company's new office in Scotland at 157 West George Street, Glasgow, C.2.

MR. A. H. HIRD, A.C.G.I., B.Sc., M.I.Mech.E., has been appointed to the board of directors of Vickers, Ltd., Vickers House, Broadway, Westminster, London, S.W.1. He is a director of Vickers-Armstrongs, Ltd., and Metropolitan-Cammell Carriage & Wagon Co., Ltd., and chairman of several wholly-owned subsidiaries of Vickers, Ltd.

MR. JOHN DUNKERLEY, for the past two years manager of Henry Broadbent, Ltd., Sowerby Bridge, Yorks, a subsidiary of Kerry's (Great Britain), Ltd., has been appointed a director of the former company. Mr. Dunkerley was for 20 years associated with Textile Machinery Makers, Ltd., Oldham.

MR. T. WORSNOP, engineering department manager of Ransomes & Rapier, Ltd., Ipswich, has retired after 43 years' service with the company. After serving his apprenticeship with Joseph Booth & Bros., Rodley, near Leeds, he joined the engineering staff of Ransomes & Rapier in April, 1915. He has been responsible for the design and development of many types of Rapier cranes.

MR. W. A. C. MCINTYRE, formerly technical sales manager of Fielding & Platt, Ltd., has joined Reed Brothers (Engineering), Ltd., Replant Works, Woolwich Industrial Estate, London, S.E.18, as a director. He will be chiefly responsible for expanding the company's manufacturing programme of hydraulic presses in their new and larger works and machine shop.

MR. K. DRUCE, D.F.H., A.M.I.E.E., has been appointed manager of the Bristol office of the English Electric Co., Ltd., with responsibility for the South-West of England territory, in succession to Mr. T. Robinson. MR. H. GRANVILLE-BROWN, A.I.E.E., has taken charge of the Southampton office of the company, which has moved to new premises at 29 Shirley Road, Southampton. In this position he succeeds Mr. I. Mackintosh.

DR. C. HOELZER, senior partner and managing director of Th. Kieserling & Albrecht, Solingen, recently celebrated his 75th birthday. He has been associated with the firm for many years, and took over the technical management at the early age of 32. In recognition of his work as a designer he was appointed an honorary member of the Technological College of Hanover, and was awarded an honorary doctor's degree by the College of Darmstadt.

Just before the end of the war the company's premises were completely destroyed, and it was largely due to the energy of Dr. Hoelzer that they were rebuilt and equipped. Today more than 1,000 people are employed in the production of mechanical presses, special machines for the forging industry, bolt and nut machinery, and standard and special cold forming machines.

## U.S. Machine Tool Exports

The following table gives the quantities and values of exports of various classes of machine tools from U.S.A. during April, 1957:

| | Number | Value, $ |
|---|---|---|
| Engine and tool room lathes | 73 | 212,881 |
| Light duty and bench lathes | 233 | 78,335 |
| Turret lathes | 16 | 220,074 |
| Other lathes | 106 | 1,610,942 |
| Vertical boring and turning mills | 1 | 63,848 |
| Boring machines | 37 | 1,145,728 |
| Tapping and threading machines | 132 | 282,712 |
| Milling machines | 79 | 701,539 |
| Gear-cutting machines | 64 | 922,390 |
| Gear-grinding and finishing machines | 17 | 258,528 |
| Drilling machines | 165 | 333,844 |
| Planing, shaping and slotting machines | 17 | 120,070 |
| Surface grinding machines | 52 | 255,135 |
| Tool and cutter grinding machines | 92 | 251,762 |
| Other grinding machines | 77 | 1,848,013 |
| Honing and lapping machines | 18 | 61,916 |
| Broaching machines | 9 | 203,115 |
| Sheet and plate metal-working machines | 415 | 3,568,964 |
| Forging machines and hammers | 43 | 1,081,611 |
| Metal forming machines | — | 978,785 |
| Other machines | 994 | 959,386 |

## Books Received

BEITRAG ZUR SICHERHEIT VON UMLAUFENDEN SCHLEIFKÖRPERN. By Dr. Ing. Hermann Münnich. Kommissionsverlag H. E. Ummen, Bahnhofstrasse 18, Höxter/Weser, Germany. 272 pp. [Price 29.40 D.M.]

This book describes investigations concerned with the safe operation of grinding wheels. The author first analyses, mathematically, the forces operating in a rotating wheel, and then shows how the wheel may be tested statically for deflection, etc. Considerable experimental data concerning destructive tests on grinding wheels have been collected and presented in graphical form. The deformation of cup wheels due to centrifugal force and to out-of-balance is also discussed, together with the damaging effects of lead balancing inserts when incorrectly positioned. In addition, the effects of mounting methods and of grinding wheel proportions are examined.

For all those concerned with the design, manufacture and application of grinding wheels, the book provides theoretical and experimental data which should prove of considerable assistance.

## Machine Tool Share Market

The undertone of stock markets was generally firm during the past week, but quiet conditions prevailed in most sections, and price movements were small and irregular.

Interest was centred mainly in the gilt-edged market, where British Funds and other high-grade fixed interest stocks moved to higher levels under the influence of the strength of sterling, and on steady investment support.

Activity among commercial and industrial shares remained at a low ebb, and while prices showed some irregularity, the majority of changes were moderately lower on balance. Nevertheless, a few good features have been in evidence.

Among machine tool issues Edgar Allen lost 3d. at 29s. 9d.; Birmingham Small Arms, 1s. at 26s.; Broom & Wade, 1s. at 10s. 6d.; Modern Engineering, 1s. at 10s.; British Oxygen, 7½d. at 31s. 3d.; Craven Bros. (Manchester), 1s. 1½d. at 5s. 9d.; B. & S. Massey, 6d. at 7s. 3d.; and Samuel Osborn, 1s. 6d. at 73s. On the other hand, Coventry Gauge & Tool improved 6d. to 15s. 6d.; Jones & Shipman, 1s. 3d. to 23s. 9d.; F. Pratt, 6d. to 20s. 6d.; and John Shaw & Sons (Wolverhampton), 1½d. to 12s. 6d.

BROOM & WADE, LTD. Final dividend 10 per cent, making, with the interim, a total distribution of 12½ per cent (same).

| COMPANY | | Demon. | Middle Price |
|---|---|---|---|
| Abwood Machine Tools, Ltd. | Ord. | 1/- | 1/-xd |
| Armstrong, Stevens & Son, Ltd. | Ord. | 5/- | 8/6 ex rights |
| Allen (Edgar) & Co., Ltd. | Ord. | £1 | 29/9 |
| " " | 5% Prf. | £1 | 15/-* |
| Arnott & Harrison, Ltd. | Ord. | 4/- | 14/- |
| Asquith Machine Tool Corp., Ltd. | Ord. | 5/- | 18/6 |
| " " | 6% Cum. Prf. | £1 | 17/9 |
| Birmingham Small Arms Co., Ltd. | Ord. | £1 | 26/- |
| " " " | 5% Cum. "A" Prf. | £1 | 15/- |
| " " " | 6% Cum. "B" Prf. | £1 | 17/6 |
| " " " | 4% 1st Mort. Deb. | Stk. | 84½ |
| British Oxygen Co., Ltd. | Ord. | £1 | 31/3 |
| " " | 6½% Cum. Prf. | £1 | 20/6 |
| Brooke Tool Manufacturing Co., Ltd. | Ord. | 5/- | 5/6 |
| Broom & Wade, Ltd. | Ord. | 5/- | 10/6 |
| " " | 6% Cum. Prf. | £1 | 16/10½ |
| Brown (David) Corporation, Ltd. | 5½% Cum. Prf. | £1 | 12/6 |
| Buck & Hickman, Ltd. | 6% Cum. Prf. | £1 | 17/6 |
| Butler Machine Tool Co., Ltd. | Ord. | 5/- | 9/3xd |
| " " | 5% Cum. Prf. | £1 | 15/9 |
| C.V.A. Jigs, Moulds & Tools, Ltd. | 5½% Red. Cum. Prf. | £1 | 13/9 |
| Churchill (Charles) & Co., Ltd. | Ord. | 2/- | 4/9 |
| " " " | 6% Cum. Prf. | £1 | 26/3† |
| Churchill Machine Tool Co., Ltd. | Ord. | 5/- | 17/4½ |
| " " " | 6% Cum. Prf. | £1 | 18/9 |
| Clarkson (Engrs.), Ltd. | Ord. | 5/- | 10/6 |
| Cohen (George), Son & Co., Ltd. | Ord. | 5/- | 10/6 |
| " " " | 4½% Cum. Prf. | £1 | 14/3 |
| Coventry Gauge & Tool Co., Ltd. | Ord. | 10/- | 15/6 |
| " " " | 5% Cum. Red. Prf. | £1 | 13/9 |
| Coventry Machine Tool Works, Ltd. | Ord. | 4/- | 8/6 |
| Craven Bros. (Manchester), Ltd. | Ord. | 5/- | 5/9 |
| Elliott (B.) & Co., Ltd. | Ord. | 1/- | 3/- |
| " " | 4½% Red. Cum. Prf. | £1 | 13/9 |
| Export Tool & Case Hardening Co., Ltd. | Ord. | 2/- | 1/9 |
| Firth Brown Tools, Ltd. | 4% Cum. Prf. | £1 | 12/- |
| Greenwood & Batley, Ltd. | Ord. | £1 | 46/10½ |
| Harper (John) & Co., Ltd. | Ord. | 5/- | 14/6 |
| " " | 4½% Red. Cum. Prf. | £1 | 12/9 |
| Herbert (Alfred), Ltd. | Ord. | £1 | 57/6 |
| Holroyd (John) & Co., Ltd. | "A" Ord. | 5/- | 11/- |
| " " " | "B" Ord. | 5/- | 10/- |
| Jones (A. A.) & Shipman, Ltd. | Ord. | 5/- | 23/9 |
| " " " | 7% Cum. Prf. | 5/- | 5/- |
| Kayser, Ellison & Co., Ltd. | Ord. | £1 | 55/6 |
| " " " | 6% Cum. Prf. | £1 | 18/3 |
| Kendall & Gent, Ltd. | Ord. | 5/- | 8/- |
| Kerry's (Gt. Britain), Ltd. | Ord. | 5/- | 6/- |
| Kitchen & Wade, Ltd. | Ord. | 4/- | 11/- |
| Martin Bros. (Machinery), Ltd. | Ord. | 2/- | 2/4½ |
| Massey, B. & S., Ltd. | Ord. | 5/- | 7/3xd |
| Modern Engineering Machine Tools, Ltd. | Ord. | 5/- | 10/- |
| Newall Engineering Co., Ltd. | Ord. | 2/- | 5/- |
| Newman Industries, Ltd. | Ord. | 2/- | 2/9 |
| " " " | 6% Prf. Ord. | 5/- | 5/6xd |
| Noble & Lund, Ltd. | Ord. | 2/- | 4/9 |
| Osborn (Samuel) & Co., Ltd. | Ord. | 10/- | 73/- |
| " " " | 5½% Cum. Prf. | £1 | 25/6 |
| Pratt (F.) & Co., Ltd. | Ord. | 5/- | 20/6 |
| Scottish Machine Tool Corporation, Ltd. | Ord. | 4/- | 4/9 |
| Shardlow (Ambrose) & Co., Ltd. | Ord. | £1 | 35/- |
| Shaw (John) & Sons, Wolverhampton, Ltd. | Ord. | 5/- | 12/6 |
| Sheffield Twist Drill & Steel Co., Ltd | Ord. | 4/- | 35/- |
| " " " | 5% Cum. Prf. | £1 | 15/- |
| Stedall & Co., Ltd. | Ord. | 5/- | 5/3 |
| Tap & Die Corporation, Ltd. | Ord. | 5/- | 8/- |
| " " " | 4½% Deb. 1961-1977 | Stk. | 82/- |
| Wadkin, Ltd. | Ord. | 10/- | 20/- |
| Ward (Thos. W.), Ltd. | Ord. | £1 | 70/7½ |
| " " | 5% Cum. 1st Prf. | £1 | 15/- |
| " " | 5% Cum. 2nd Prf. | £1 | 23/9 |
| Willson Lathes, Ltd. | Ord. | 1/- | 2/4½ |

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. † Birmingham price.

# PRICES OF MATERIALS

All prices per ton except where otherwise stated.

## Pig-Iron

### Foundry and Forge No. 3, Class 2

| | |
|---|---|
| Middlesbrough zone | £21 6 0 |
| Birmingham | £20 18 3 |

### Phos. 0·1 to 0·75%

| | |
|---|---|
| Birmingham | £23 17 0 |

### Scottish Foundry

| | |
|---|---|
| Grangemouth | £25 3 6 |

### Hæmatite English No. 1

| | |
|---|---|
| N.E. and N.W. Coast | £25 6 6 |
| Scotland | £25 13 0 |
| Sheffield | £26 15 0 |
| Birmingham | £27 4 0 |

### Welsh

£25 6 6

## Steel Products

| | |
|---|---|
| Medium plates | £46 1 6 |
| Mild steel plates, ordinary* | £42 12 0 |
| Boiler plates* | £45 2 0 |
| †Flat bars 5 in. wide and under / †Round bars under 3 in. | £40 8 0 |
| Billets, rolling quality, soft U.T. | £33 1 6 |

## Phosphor Bronze

Ingots (2B8) (A.I.D.) d/d — Nominal

## Copper

| | |
|---|---|
| Cash (mean) | £173 7 6 |
| Cold rolled and hot rolled Sheets 4 ft. by 2 ft. by 10 SWG | £243 10 0—£243 15 0 |
| Rods ⅜ in. to 4 in. diam. | £261 5 0 |
| Tubes, 1½ in. bore by 10 SWG, ton lots, per lb. | 2s. 6½d. |
| Wire rod, black, hot-rolled (½–⅞ in.) English | £192 17 6 |

## Zinc

| | |
|---|---|
| Refined, minimum 98 per cent. purity, current month (mean) | £62 12 6 |

## Brass

| | |
|---|---|
| Tubes, solid drawn, per lb. | 1s. 5½d. |
| Strip 63/37, 6 in. by 10 SWG coils, ton lots | £209 5 0—£211 15 0 |
| Rods, ½–3 in. diam. (59 per cent copper) | 1s. 8½d. |

## Yellow Metal

| | |
|---|---|
| Condenser plates, per ton | £147 0 0 |
| Rods, per lb. | 1s. 9½d. |

## Aluminium

| | |
|---|---|
| Ingots min. 99·5 per cent Canadian d/d | £197 0 0 |

## Lead

| | |
|---|---|
| Refined, minimum 99·97 per cent purity, current month (mean) | £72 12 6 |

## Tinplates

| | |
|---|---|
| ‡U.K. Home trade: Handmill f.o.t. makers' works | £3 12 4½ |
| Cold reduced, f.o.t. makers' works | £3 8 0½ |
| U.K. Export: Hot rolled basis, f.o.t. works' port | 74s. 0d.—75s. 0d. |
| Cold reduced basis, f.o.t. works' port | 76s. 0d.—76s. 6d. |

## Gunmetal

| | |
|---|---|
| Ingots, 85.5.5.5. ex works | £166 0 0 |

*N.E. Coast, N. Joint Area, Central Scottish Zone.

†U.T. soft basic.

‡Official maximum price, after allowing for adjustments for increase in price of tin.

## MAKERS' PRICES

### Hexagon Steel Bars[1]

| | |
|---|---|
| Sizes in inches from 0·7049 up to 2·21 and 2·41 a/f, ex works basis | £43 4 6 |
| Free cutting black | £47 10 0 |

### Reeled Steel Bars[1]

| | |
|---|---|
| Single-reeled 1½ in. upwards, f.o.t. works (+ usual extra for sizes) | £43 17 6 |
| Free cutting | £48 2 6 |

### High-Speed Steel

Black random length bar. All prices basic, per lb., subject to extras.

| | |
|---|---|
| Molybdenum "66" | 6s. 0½d. |
| Molybdenum "46" | 5 10½d. |
| 14 per cent tungsten | 6s. 3d. |
| 16 per cent tungsten | 6s. 8½d. |
| 18 per cent tungsten | 7s. 0d. |
| 22 per cent tungsten | 8s. 3d. |
| 5 per cent cobalt | 10s. 2d. |
| 4·75/5·25 per cent molybdenum + 6·0/6·75 per cent tungsten + 1·75/2·05 per cent vanadium (5-6-2) | 6s. 2½d. |

### Precision-ground, High-speed Free-turning Brass Rod[2]

| | |
|---|---|
| ½-in. dia. ± 0·00025-in. 2-ton lots, per lb. | 2s. 3½d. |

### Grey Iron Rod

Die Cast[3] in random lengths 18 in. to 24 in. rough machined ⅛-in. above listed size. Extra for definite lengths, for hardenable alloy iron, and for orders of less than £50. Discounts for orders over £150.

| | Per cwt. net. Mark I | Mark III |
|---|---|---|
| ¼ or ⅜ in. | 255s. 6d. | 318s. 10d. |
| ½ or ¾ in. | 204s. 4d. | 251s. 10d |
| 1 to 1½ in. | 143s. 0d. | 171s. 2d. |
| 1¾ to 2 in. | 106s. 2d. | 125s. 11d. |
| 2¼ to 3¼ in. | 91s. 6d. | 106s. 4d. |
| 3¾ to 12 in. | 86s. 6d. | 99s. 2d. |

Continuous Cast

10-ft. lengths, centreless machined 1 to 3-in. dia. + 0·010 to 0·020 in., prices as quoted for die cast bar[3]

| | | |
|---|---|---|
| 6-ft. lengths centreless ground + 0·010 in. Extra for hardenable alloy iron[4] Per cwt. net. | ¾ or ⅞ in. | 245s. 4d. |
| | 1 or 1¼ in. | 196s. 4d. |
| | 1¼ to 1¾ in. | 137s. 10d. |
| | 1¾ to 2 in. | 106s. 2d. |
| | 2¼ to 3 in. | 91s. 6d. |

### Stellite[5]

Welding Rods (plain)

| | |
|---|---|
| ¼ in. dia. per lb. | 30s. 0d. |

Toolbits

| | |
|---|---|
| ¼ in. sq. × 4 in., each | 22s. 3d. |

### Precision-ground Mild Steel[2]

| | |
|---|---|
| 1-in. dia. ± 0·00025-in. 4-ton lots, per cwt. | 121s. 6d. |

1 Colvilles, Ltd., Glasgow, and 17 Grosvenor Street, London, W.1. 2 Pratt, Lavick & Co., Ltd., Chester. 3 Sheepbridge Alloy Castings, Ltd., Sutton-in-Ashfield. 4 "Flocast," Harold Andrews Sheepbridge, Ltd., Halesowen. 5 Deloro Stellite, Ltd., Highlands Road, Shirley, Solihull.

## BASIC PRICES FROM LONDON STOCK[6]

### Free Cutting Steel

| | |
|---|---|
| Bright cold drawn: (Usaspead) over 1½ to 2 in. | £59 17 6 |
| Lead bearing (Usaled) | £63 17 6 |
| Precision ground, 1½ in. | £81 12 6 |

### Bright Drawn

| | |
|---|---|
| M.S. bars (M.M.C.) over 1½ in. to 2 in. | £55 8 6 |
| Square edge flats (Usaflat) | £72 5 0 |
| M.S. angles (Usaspead) | £99 10 0 |
| Casehardening (EN) (Usacase) over 1½ in. to 2 in. | £63 14 6 |
| M.S. bars (EN3B) (Usamild) over 1½ to 2 in. | £57 8 6 |
| Carbon manganese semi-freecutting case hardening (EN202) (Usaspead 202) over 1½ to 2 in. | £71 14 0 |
| 35/45 ton tensile (EN6) (Usen) over 1 to 1½ in. | £65 2 6 |
| 0·4 Carbon Normalised (Usaspead "40") over 1½ in. to 2 in. | £67 4 6 |
| Carbon manganese steel to Specification EN.16.T (Usaspead 5565), per ton | £127 10 3 |

### Ground Flat Stock

18-, 24-, and 36-in. lengths (Usaspead). List prices less 5 per cent.

### Oil Hardening Cast Steel

| | |
|---|---|
| Non-shrink (Usaspead N.S.O.H.) ¾ in. to 2¾ in., per lb. | 1s. 11d. |
| Non-distorting heavy duty (Usaspead H.C.H.C.) ¾-in. to 2¾-in., per lb. | 4s. 2d. |

### Silver Steel

(0·194-in. to 1¼-in.)

| | |
|---|---|
| Genuine Stubs quality, per lb. | 4s. 6d. less 27½% |
| M.M.C. quality, per lb. | 2s. 5d. + 64% |
| Boxes of 16 assorted sizes ⅛-in. to ¾-in. dia. | 7s. 6d. |

### Stainless Steel

K.E. 40.AM (Freecutting), per lb. 3s. 3½d.

### Glacier Machined Bronze Bars

Phosphor bronze (2B8) / Lead bronze — Prices on application

### High-speed Steel

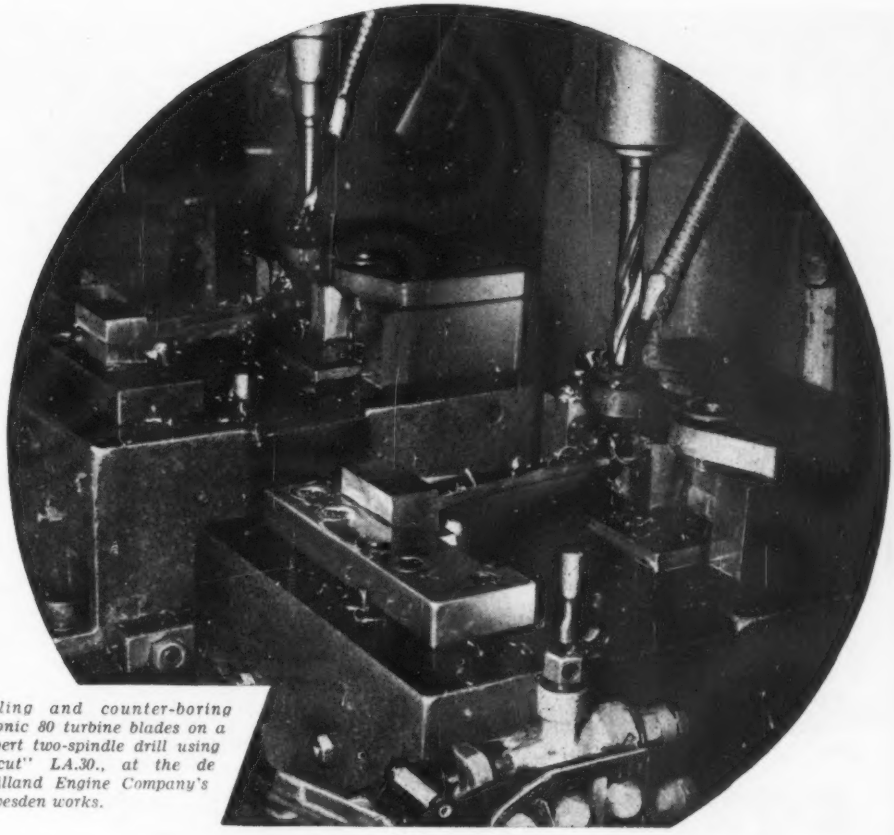
18 per cent. tungsten. Prices on application. Toolholder bits:

Usaspead "Super" / "Supreme" / Cobalt 10 — List price

### Shimstock

| | |
|---|---|
| Steel assorted, per tin | 3s. 6d. |
| Brass " " | 7s. 3d. |

6 Macready's Metal Co., Ltd., Pentonville Road, N.1. Subject to confirmation by London Office. Delivered free by van in London area.



*Drilling and counter-boring Nimonic 80 turbine blades on a Herbert two-spindle drill using "Ilocut" LA.30., at the de Havilland Engine Company's Leavesden works.*

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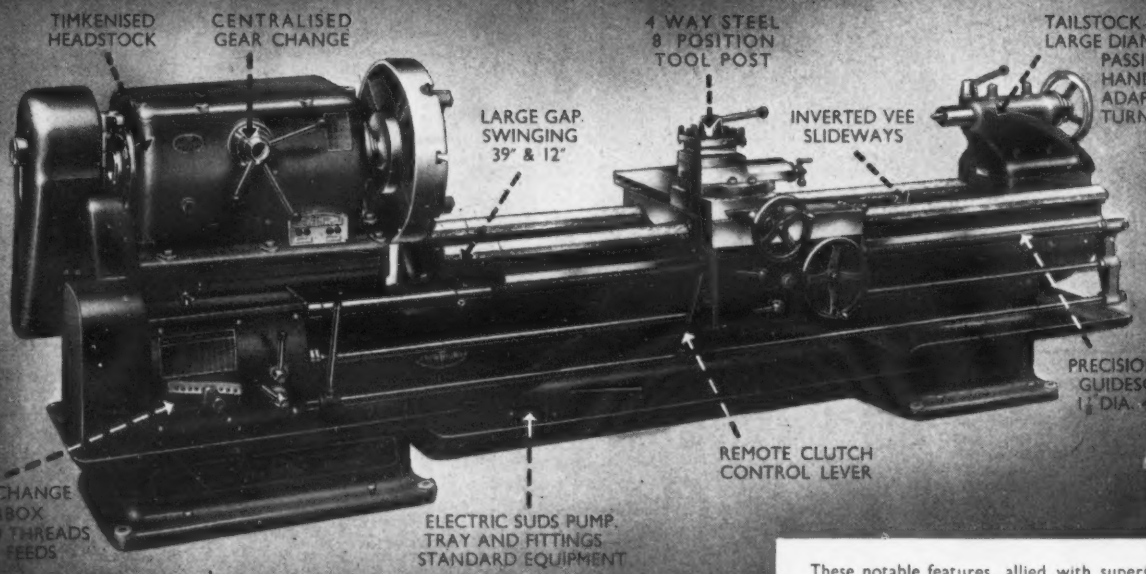


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(BROCKWORTH) LTD.

Galtona O-K

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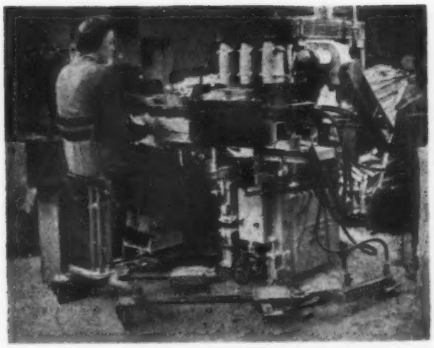
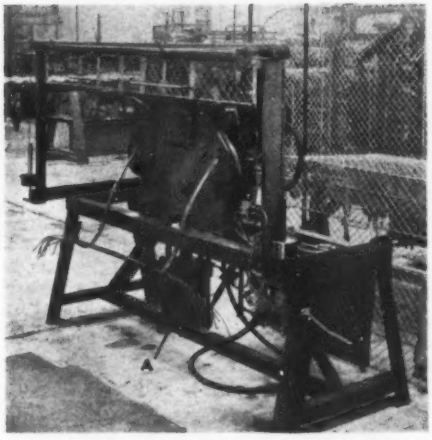
NORTHERN IRELAND: Garage & Engineering Supplies Ltd., 78 Great Victoria Street, Belfast.
SCOTLAND: Stuart & Houston, 5 York Street, Glasgow C.2.

C/1/1



**WOODWORKING**

**RADAR EQUIPMENT**



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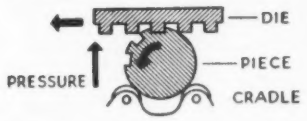
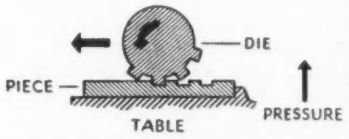



Each round part is located in a cradle and is raised under pressure against a flat die carried in the head. The die then traverses and the impression is made in the part smoothly and evenly.




Each flat part is located in a holding fixture and is raised under pressure against a round die carried in the head. As the die traverses, it rotates, making the impression in the part. In both cases a small portion of the die only is in contact with the piece and positive pressure ensures a consistently clean mark. Shock impact is practically eliminated.

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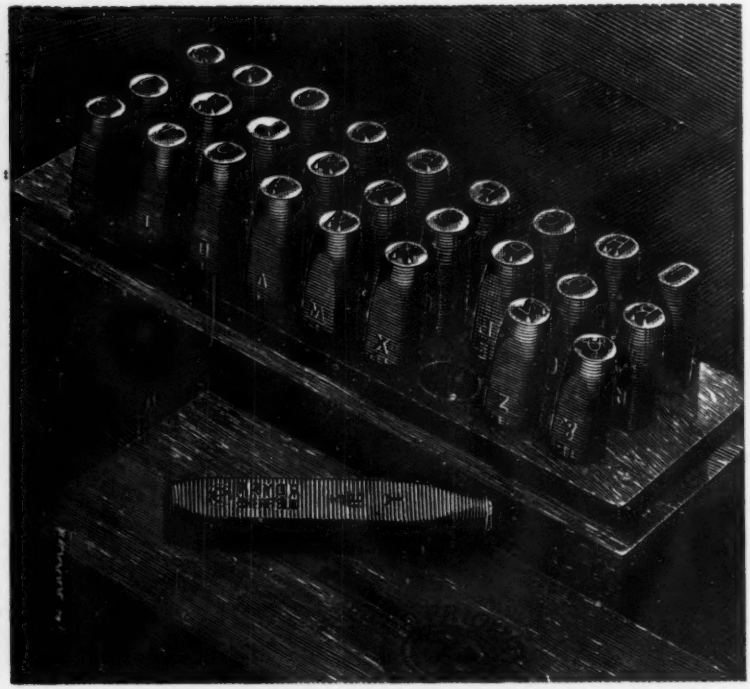
N2



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**ACME-GRIDLEY** 6$\frac{1}{4}$in. Six-Spindle Chucking Automatics.
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**B.S.A.** 9in. Single-Spindle Chucking Automatic.
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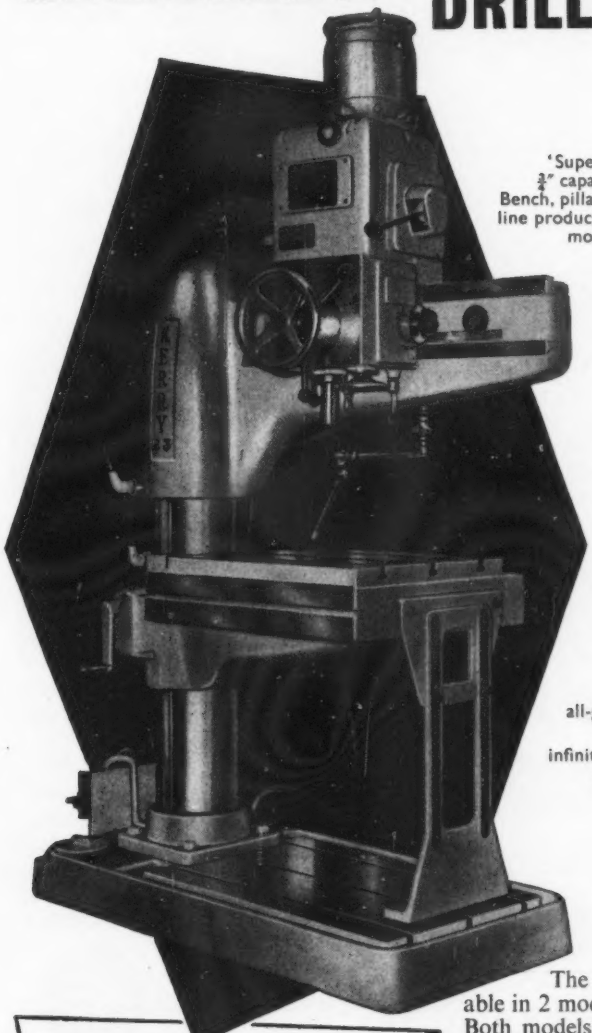
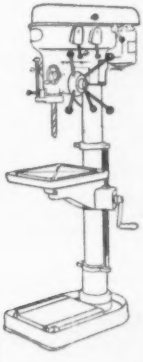


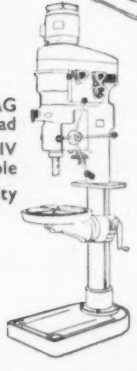
'Super 8'
¾" capacity
Bench, pillar or line production models

'Drillmaster'
½" capacity
Bench, pillar or line production models

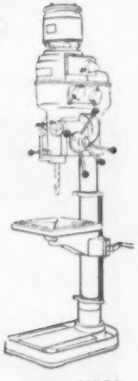
'100'
1" capacity



'150' AG
all-geared head
'150' IV
infinitely variable
1½" capacity



'125'
1¼" capacity



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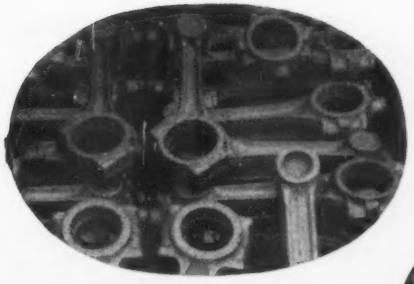

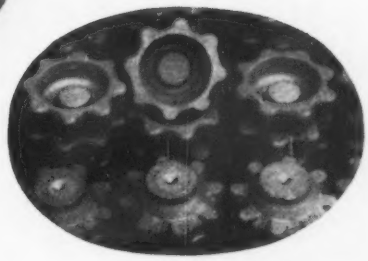

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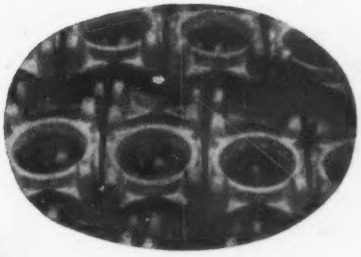

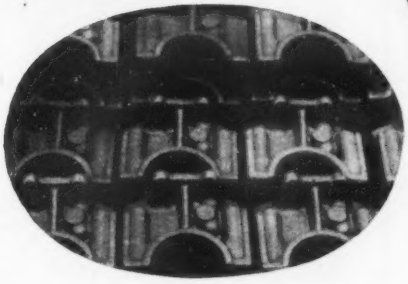

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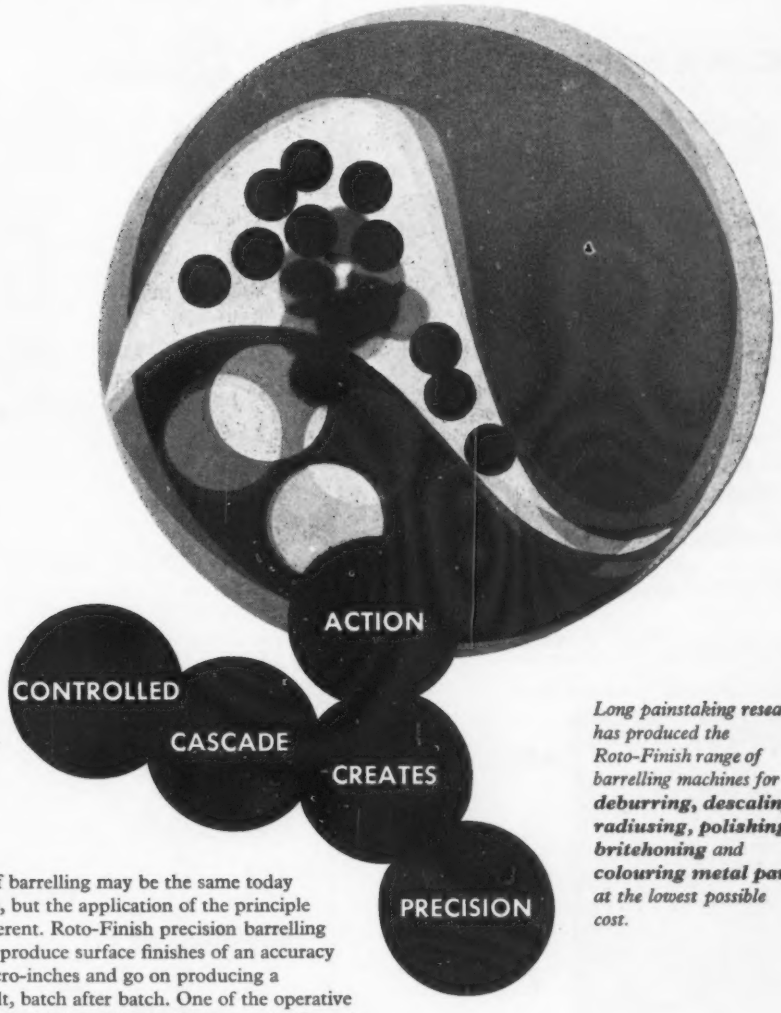


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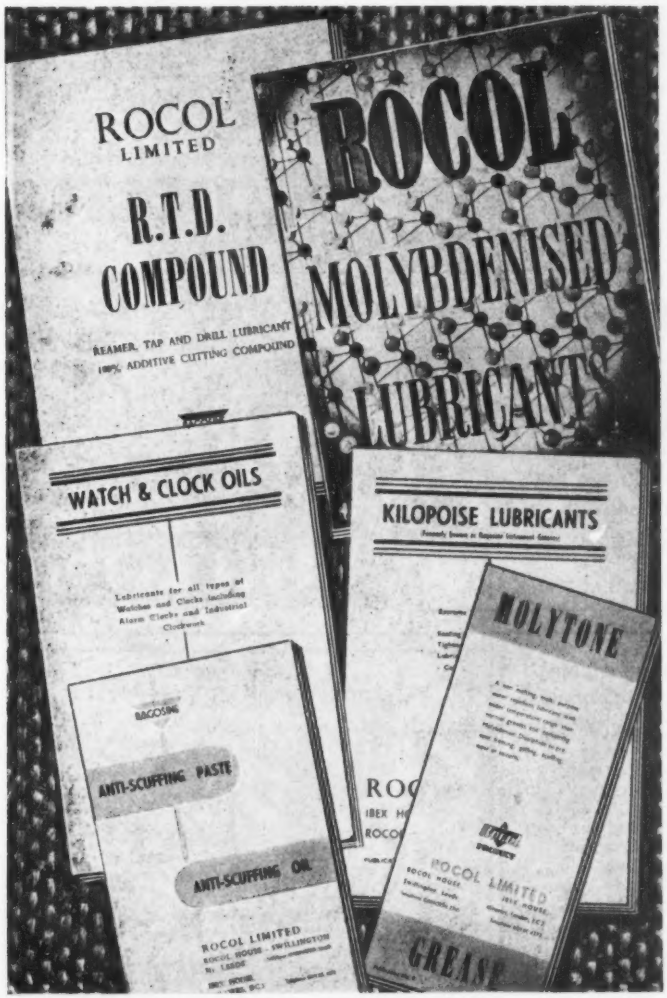


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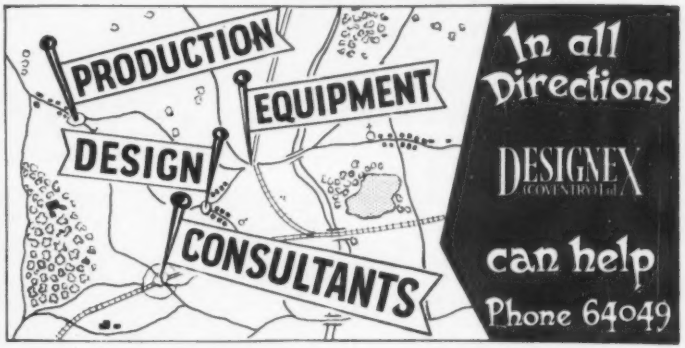


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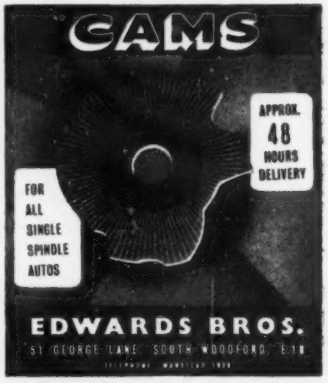


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**BROWN & SHARPE** No. 2 18in. by 6in. Surface Grinder.
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**ARCHDALE** 20in., 37in. by 10in. table.
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**BROWN & SHARPE** 000 production miller.
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**EDGWICK** 18in. traverse, 40in. by 12in. table.

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|---|---|
| Spindle dia. ... ... ... | 3½in. |
| Range of speeds ... | 35-1,200 r.p.m. |
| Traverse ... ... ... | 24in. |
| Size of Table ... | 39in. by 34in. |
| Rotates through ... ... | 360 deg. |
| Max. distance spindle to table ... | 32in. |
| Longitudinal traverse ... ... | 36in. |
| Cross traverse ... ... ... | 32in. |
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| Approximate weight ... | 6 tons |

**PRICE £4,950**

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**Horizontal Milling Attachment with two Arbors 1¼in. and 1½in. dia.**
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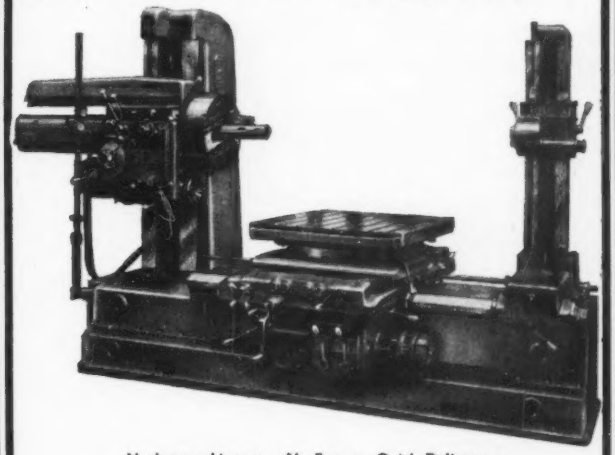

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Milling Machine, 28in. by 9in., with vertical attachment.

**ALBA** 4S 18in. Shaper, with swivel vice.
**TRIDENT** Vertical Miller, 30in. by 6½in., swivel head, auto feeds.

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Section Forming Machine with additional curving unit. Specially suitable for profiling and banding stainless steel sections. Drive is by 20-h.p. motor through 3-speed gearbox. Diameter of roller shafts 2in. Length of shafts available for forming rollers 8½in. Rolling speeds with 6in. diameter rollers, 40, 80 and 120ft. per minute. Weight about 11¼ tons.—Full details and illustrations from F. J. EDWARDS LIMITED, 359-361, Euston Road, London, N.W.1, or 41, Water Street, Birmingham 3.

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" HLA " HEAVY DUTY CYLINDRICAL, 16in. × 24in.—84in.
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" KN " INTERNAL, ½in. to 5½in. bores.
" KFG " ANGLE HEAD, 12in. × 24in. and 12in. × 36in.

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**Newall Plain Cylindrical Grinding** Machine, 10in. by 24in., motorised 400/3/50.—SOUTHERN ENGINEERING & MACHINERY CO., Connaught Buildings, Tanners Brook, Millbrook, Southampton. Tel.: Southampton 73101.

**Rapidor Manchester Major Hacksaw** Machine. Motorised 400/3/50. In Stock for your inspection.—JAMES W. CARR & CO., LTD., 7/15, Rosebery Avenue, London, E.C.1. Tel.: Terminus 8866 (P.B.X.).

**Wild-Barfield Furnace, Type** No. CTO1612. Celltype forced air circulating tempering furnace. Temperature range 0-700 deg. C. Contactor panel by Brookhirst, Cambridge controller. Current supply 415/3/50. 10 kW. Size 18in. by 18in. inside dims.—BOX T686, MACHINERY, Clifton House, Euston Road, N.W.1.

**Reconditioned Wild-Barfield** Furnace. 0-1,050 deg. temperature range. Heavy hairpin 2 zone control (roof and hearth separate control). Heated door. Internal size 24in. by 48in. by 15in. high. 36 kW. 415/3/50. With contactor panel, 2 oil cooled transformers. C.A. couples.—BOX T706, MACHINERY, Clifton House, Euston Road, N.W.1.

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**One Loewe SW2 Tool and Cutter** Grinder. Table mounted on roller chain bearings. Table 31½in. long by 4½in. wide, with swivelling adjustment. Wheelhead fully rotating with wheels mounted at both ends of spindle. Fully motorised 400-415/3/50, 0.012kW, 2,840 r.p.m. Overall size 4ft. 10in. wide by 4ft. high by 3ft. 6in. deep. Equipment: One fully adjustable vice.—BOX V288, MACHINERY, Clifton House, Euston Road, N.W.1.

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| 100 | Asea | Slipring | 200 |
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## USED LATE TYPE MACHINES

### LATHES

**DEAN, SMITH & GRACE.** A.G.H., 10¼in. centre by 10ft. between, 35in. gap.
**COVMAC** Lathe, 8¼in. by 60in. between, A.G.H., gap bed, spindle speeds 18-450 r.p.m., mot. 415/3/50.
**CHURCHILL CUB** Lathe, 6in. by 24in., A.G.H., mot. 415/3/50.

### CAPSTANS AND AUTOS

**WARD** No. 7, A.G.H. Bar feed, ball chuck, etc. Motorised.
**WARD** 2A. Oversize spindle, complete with ball chuck, bar feed, and quantity of collets for 2A size. Motorised 415/3/50.
**WARD** 3A. Oversize spindle, complete with ball chuck, bar feed. Motorised 415/3/50.
**WARD** OE Capstans, ¼in. collet cap., 480/2,850 r.p.m. Bar feed, mot. coolant pump 400-440/3/50 A.C.
**WARD** 1A Capstans, 1in. collet cap. H.S. range up to 4,130 r.p.m. Ball chuck, bar feed, mot. coolant pump, 400-440/3/50 A.C.
**HERBERT** 2D Capstans, 16 speeds, 50/2,550 r.p.m. Draw-in collet, bar feed, power feed turret, "duo-rate" cross slide, "Flamard" bed, mot. coolant pump 415/3/50.
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**HERBERT** No. 0 Capstans, ¼in. cap. Dead length air chucks, 12 speeds 93/6,000 r.p.m., mot. coolant pump, 415/3/50.
**BOLEY & LEINEN** Precision Capstan. Model S.R.26. Collet cap. 1in., mot. 415/3/50.
**INDEX** O.R.12 Auto., ¼in. cap. Flange mot. 415/3/50.

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**CLEVELAND** No. 1 Horizontal Borer. Spindle No. 5 M.T., compound table, with motor.
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**LANDIS** Hydraulic Cylindrical Grinder, 12in. by 48in., mot., reconditioned.
**NEWAL** Hydraulic Cylindrical Grinder, 12in. by 24in., mot.
**SNOW** P.24 Surface Grinder. Cap. 24in. by 8in. Hydraulic variable feed to table, wheel dia. 10in., mot. 400/3/50 A.C.
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**MAXIMILLER** 4P Heavy Duty Vertical Milling Machine, table 76in. × 18in., 42in. traverse.
**MILWAUKEE** 4H Heavy Duty Vertical Milling Machine, speeds 20 to 1,000 r.p.m., power down feed head.
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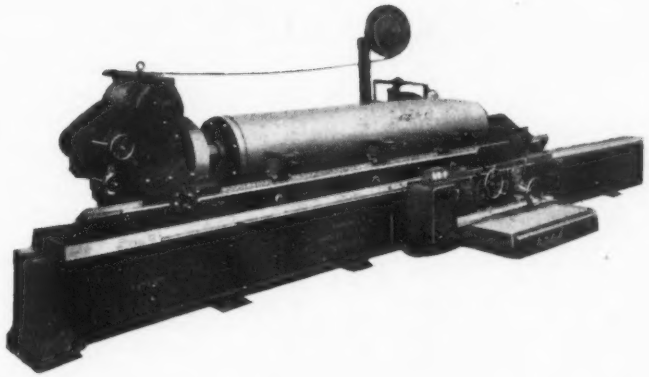

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**Milwaukee Vertical Milling Ma-** chine No. 1½B. Table size 11½in. by 45in., moves 31in. Slide moves 10in. Rise and fall of table 12in. Motor 400-440, 4 h.p.—BOX V494, MACHINERY, Clifton House, Euston Road, N.W.1.

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**Capstan or Turret Setter Oper-**ators required for Ward 7 or Ward 3A. Only highly skilled men accustomed to turning out absolutely first-class quality work need apply. The wages are top-grade. Plenty of overtime plus bonus, sick pay, etc., and pension scheme after establishment. Housing provided after 3 months trial period. Also vacancy for one good young centre lathe turner.—Applications in full stating past experience, to BALDING ENGINEERING, LTD., Bessemer Road, Norwich.

**Production Superintendent for** small works in West of England, engaged in close limit aircraft component production. State age, experience and salary required.—BOX V262, MACHINERY, Clifton House, Euston Road, N.W.1.

**Capstans—Working Foreman.** Must have extensive experience as first-class setter on close limit aircraft components. Ten Capstans, for West of England. State age, experience, salary required.—BOX V263, MACHINERY, Clifton House, Euston Road, N.W.1.

**ASSISTANT PLANNING ENGINEER**

Required with Machine Tool or similar manufacturing experience, for operation layouts on batch and prototype work. Some knowledge of tooling and mathematics would be useful. Excellent prospects for a young man (up to 35 years) seeking a permanent career. Send full details of age, education, experience and present salary to Personnel Manager,

**W. E. SYKES LTD.**
**Manor Works, Staines, Middx.**

**Setter Mechanic, Experienced** packaging machinery required for North London factory. Excellent conditions, non-contributory pension scheme.—Apply PERSONNEL OFFICER, INTERNATIONAL CHEMICAL CO., LTD., Braydon Road, N.16.

**Hardinge Machine Tools Ltd.,** require a highly qualified designer, particularly experienced in design development of light machine tools of at least Swiss precision. Applicants must be capable of ideas which will keep Hardinge machines in the forefront of their field. This is a Senior appointment carrying high salary.—Apply MANAGING DIRECTOR, Hampton Road West, Hanworth, Middlesex.

**Sales Engineer Required by** City firm (E.C.3) for London and the South East with experience in machine tools and industrial plant. Only men of initiative, good presence and sound technical background need apply. Staff notified. Applications treated strict confidence.—Fullest details age, experience, salary, BOX V240, MACHINERY, Clifton House, Euston Road, N.W.1.

**Chief Estimator Required for** engineering firm in Coventry, to take charge of Estimating Department. Experience in estimating for Jigs, Fixtures, Press Tools, etc., essential. This is a responsible position, with a commensurate salary. Every amenity, pension scheme, and excellent prospects of advancement. Also Works Manager to take full control of Works, Works Personnel, Production Control, etc. Experience in such work essential. Good salary, pension scheme, together with excellent prospects in an expanding organisation.—Please apply with full particulars to BOX V260, MACHINERY, Clifton House, Euston Road, N.W.1.

**Ratefixer (Assistant), Age 25-30,** with similar previous experience in general machine shop and/or light electro-mechanical assemblies required. Applicants who have served an engineering apprenticeship preferred. Five-day week. Contributory Pension Scheme. —Apply with full details of career and salaries earned to PERSONNEL MANAGER, THE PHOENIX TELEPHONE AND ELECTRIC WORKS, LTD., The Hyde, N.W.9.

**Designer-Draughtsman, 25-30** years, required in London by rapidly expanding company for examining customers' enquiries on mechanical applications of the company's products. Design experience in machine-tool and motor industry an advantage. This appointment offers a wide insight into nearly every type of engineering process in this country and personal contact with customers.—Apply to BOX V272, MACHINERY, Clifton House, Euston Road, N.W.1.

Classified Advertisements (*SITUATIONS VACANT, contd.*)

**Machine Tool Merchants Re**quire young person with drive and enthusiasm to be Assistant to Sales Director Prospects and income only limited by personal effort.—Reply with full particulars to BOX V182, MACHINERY, Clifton House, Euston Road, N.W.1.

**Capstans. Working Foreman.** Must have had extensive experience as first-class setter on close limit Aircraft components. New Ward machines, mixed labour, Croydon area. Applicant must have held similar position.—Write, giving particulars, experience, age and salary required, to BOX V174, MACHINERY, Clifton House, Euston Road, N.W.1.

**Planning and Estimating** Engineer required. A good practical machine shop background is required, together with previous experience as Planning Engineer. Position suitable for younger man with energy and desire to improve financial position. Small factory Croydon area, mixed labour.—Write, giving full particulars, experience, age, etc., to BOX V176, MACHINERY, Clifton House, Euston Road, N.W.1.

**Capstan Setter Required for** light engineering works in Sussex. Must be fully experienced and reliable. State age, experience, wage.—BOX V226, MACHINERY, Clifton House, Euston Road, N.W.1.

**Production Manager. Applica**tions are invited for the position of Production Manager in established medium-size electronic and light electro-mechanical company, West Middlesex area. This appointment provides excellent opportunity of permanent post for the right man with initiative and a good educational standard. Essential requirements are age 35-50 sound workshop training, preferably with H.N.C. in Production Engineering, and experience including light precision work, application of small press tools, fabrication work of type used for electronic equipment units, also batch production wiring and assembly methods. Post involves responsibility for all production engineering and manufacturing operations. Life Assurance and Pension Scheme.—Write fully in confidence, stating age, qualifications, experience, salary required, to BOX V228, MACHINERY, Clifton House, Euston Road, N.W.1.

**A Production Engineer is Re**quired to supervise the complete manufacture, construction and erection of special-purpose machines. These machines are designed by ourselves to our customers' particular requirements, and will generally be built using standard units and standard unit heads, which are also designed and manufactured by ourselves. Academic and practical training must be of a very high order, as the successful applicant will be required to work very closely with the Technical Sales Engineer and Chief Designer to make a team capable of controlling all design and manufacture. This is a new job in a comparatively new field and to a suitably trained engineer could lead to the position of Works Manager.—Apply, in writing, giving full details of age and experience, to GENERAL MANAGER, BROOKE TOOL MANUFACTURING CO., LTD., Aldridge Road, Perry Barr, Birmingham, 22b.

**Draughtsman Required, Experi**enced in plastic mould design. Good opportunities for advancement.—Write SEAFORTH, Watchett Works, Oakhurst Road, Southend-on-Sea, Essex.

## THE DE HAVILLAND ENGINE COMPANY LIMITED

**(ROCKET DIVISION)**

**PRODUCTION CONTROL**

Applications are invited from suitably qualified engineers in the age group 30 to 45 for the position of Production Controller.

Essential qualifications include a sound practical training in engineering, and applicants must possess H.N.C. or equivalent.

Proved experience in the control of production, stock control, material and shop ordering, progressing, machine loading and programming is required, together with a knowledge of modern control systems.

Experience of M.O.S. Stores procedure is desirable, but not essential.

Assistance towards housing accommodation could be arranged.

Applications (quoting Ref. SC.750) should be sent to:—

**The Personnel Officer,**
**The de Havilland Engine Company Limited,**
**Stag Lane, EDGWARE, Middx.**

## SENIOR DEVELOPMENT ENGINEER

An exceptional opportunity for a Mechanical Engineer, in the 30-40 age group, wishing to broaden his responsibilities, occurs in our organisation. The successful candidate would, after experience of our products, take charge of our Design Office and Development Dept., comprising a staff of about 45 in all.

An Honours Degree in Mechanical Engineering followed by responsible development or design experience in light to medium engineering are the minimum technical qualifications. Experience of research, especially in machine dynamics, strength of materials or elasticity would be considered valuable.

Staff conditions, salary, pension scheme, etc., are up to the standard expected by those genuinely qualified for this post.

Candidates should write initially to the Secretary, The British Northrop Loom Company Ltd., Blackburn, Lancashire.

## WORKS SUPERINTENDENT REQUIRED

Immediately by expanding firm of precision engineers in the West Midlands area, employing over 3,000 people.

An experienced practical engineer of first-class standing is required, and applicants must be conversant with modern production methods and must be able to handle labour and be a good disciplinarian.

The situation offers excellent prospects for the right type of man, it is permanent and progressive and a good superannuation scheme is available.

Write, giving full details of past experience, positions held, salary, etc., in chronological order, to Box V.232, MACHINERY, Clifton House, Euston Road, N.W.1.

## DRAUGHTSMEN

required for old-established and expanding die-casting company in North London.

Some experience of die-casting or plastic moulds essential. Salary up to £1,000 per annum. Permanent monthly staff appointment with comprehensive pension and dependants' insurance scheme.

Assistance with removal expenses in approved cases. Five-day week in pleasant modern office; canteen facilities.

*Apply with details of experience to*

**Personnel Manager Box UK. 7982**

**A.K. Advg., 212a Shaftesbury Ave., London, W.C.2.**

## OFFICE POSITION

*for man aged 25-35*

With some technical knowledge of Machine Tools to deal with correspondence and quotations, required by well-established Machine Tool Importers.

**Good prospects. Apply Box V231 MACHINERY, Clifton House, Euston Road, N.W.1**

## JIG & TOOL DRAUGHTSMEN

Required by the Hoffmann Manufacturing Company, Limited, Ball & Roller Bearing Manufacturers. We have openings for men with particular experience of PRESS TOOL WORK. Conditions of employment are good and posts are pensionable. Please apply, giving full details of age, training and experience to Personnel Manager, The Hoffmann Manufacturing Company, Limited, Chelmsford, Essex.

## TWO DESIGNERS OF SECTION LEADER STATUS

are required for Mechanical Engineering ranging from Precision Gauge and Machine Tool Work to Fabrication and Mechanical Handling. Knowledge of Instrumentation advantageous. Also a PLANNING ENGINEER with a good knowledge of Spherical Trigonometry to Plan, Supervise Manufacture and Inspection of High Precision Mechanical Engineering Projects mostly on a one off basis.

The work in both cases is largely for the Atomic Energy Authority and applicants are requested to write full details of previous experience and technical qualifications, in confidence to:—

**B.O. MORRIS, LTD.,**
**Albion Works,**
**465, Commercial Road,**
**Portsmouth.**

## JIG & TOOL DRAUGHTSMEN

Required by The Hoffmann Manufacturing Company, Limited, Ball and Roller Bearing Manufacturers. We have openings for men with particular experience of tooling MULTI-SPINDLE AUTOS. Conditions of employment are good and posts are pensionable. Please apply, giving full details of age, training and experience to Personnel Manager, The Hoffmann Manufacturing Company, Limited, Chelmsford, Essex.

### REPRESENTATIVES

**Representative Required on Commission** Basis only, to obtain Turning, Milling, Drilling, etc., and Assembly work from Trade or Ministries. Both precision jobbing and production runs. Should also be able to find contracts for manufacture of complete products, development of prototypes and design and manufacture of jigs and fixtures for Light Engineering. Small expanding company situated in Kent.—Reply in confidence to BOX V283, MACHINERY, Clifton House, Euston Road, N.W.1.

## AMBITIOUS MECHANICAL ENGINEER

**Required by Machine Tool Company as Representative in Yorkshire and surrounding area. The successful applicant will be required to have a sound practical knowledge of Machine Tools, Power Presses, etc., and to be authoritative and persevering. A high remuneration can be earned by salary and commission. Applications for interviews stating previous experience, should be addressed to**

**Box L.396, Willing's, 362 Gray's Inn Road, London, W.C.1.**

## TECHNICAL REPRESENTATIVES

required for East Midlands and West Midlands, for the sale of specialised production engineering equipment and special purpose machine tools.

Applicants must be workshop trained and able to demonstrate to production engineers.

Remuneration by fixed salary plus expenses. Car will be provided.

London interviews arranged with expenses paid—Write in strictest confidence.

**Box V276, MACHINERY,**
**Clifton House, Euston Road, N.W.1**

**Engineering Company on the** South Coast require additional representation throughout the Aircraft and General Engineering Industry and invites application from an experienced Engineer, who has sound connection with all the major Aircraft and Engineering Firms. The position calls for a man with enthusiasm and drive, and able to negotiate at top executive level, with a view to obtaining substantial contracts. References required.—Please write in first instance, stating age, experience and salary required, to BOX V213, MACHINERY, Clifton House, Euston Road, N.W.1.

**Representative Required by Firm** of Gear Cutters to take over the East Coast area in which they are already well established. Commission basis only. The remuneration would not justify full time employment but could be worked in with an existing agency in some other line. Resident near Middlesbrough. Specialised knowledge of gearing is not essential, but should have a good general engineering experience.—BOX V294, MACHINERY, Clifton House, Euston Road, N.W.1.

**Senior Technical Representative** required by leading Manufacturers of Machine Tools for London and Home Counties. This is a fine opportunity for man with experience and drive. Car provided.—Write, giving full details of experience, etc., to Managing Director, BOX V235, MACHINERY, Clifton House, Euston Road, N.W.1.

**Sales Representative Required** for press work (Light/Medium/Deep Drawn) by Company in West Middlesex area. This is a sound progressive position.—Apply, giving full details of age and experience, to BOX V265, MACHINERY, Clifton House, Euston Road, N.W.1.

**Representative Required by** small Midland Precision Engineering Company to introduce work on commission basis.—Write BOX V273, MACHINERY, Clifton House, Euston Road, N.W.1.

# SITUATIONS WANTED

**Works Manager, 20 Years as Top** executive, seeks change in Crawley or South Coast area, used to controlling 500 mixed employees, Buying, D.O. Methods, T. & M. study, tool room, machine shops, Assembly sheet metal, welding, plating, etc., etc.—BOX V188, MACHINERY, Clifton House, Euston Road, N.W.1.

**Practical Engineer, 30 Years'** experience in the Work Shops. Machining and fitting on prototypes, general and development. Present position engineers manager. Seeks similar position, or anything practical. Salary £18 0s. 0d. per week.—BOX V163, MACHINERY, Clifton House, Euston Road, N.W.1.

**Buyer, Experienced in Light** engineering, seeks situation in London.—BOX V220, MACHINERY, Clifton House, Euston Road, N.W.1.

**Universal Miller. Wide Experi-** ence production and toolroom. 30 years in trade. Seeks post where loyalty, skill, initiative and exceptional tool kit would be appreciated. Minimum starting rate 7s. 6d. per hour.—BOX V236, MACHINERY, Clifton House, Euston Road, N.W.1.

**Toolmaker, 33. 17 Years' Experi-** ence on diecast moulds, plastic moulds glued to bench, desires change. Anything considered. London area.—BOX V241, MACHINERY, Clifton House, Euston Road, N.W.1.

**Design/Development Engineer,** toolmaker, apprenticed, conscientious, hardworking. Sound background, bench, D.O., technical office, aircraft industry, labour control, general administration, technical or commercial. London/South. — BOX V292, MACHINERY, Clifton House, Euston Road, N.W.1.

**Design Engineer. M.J. Inst.E.,** M.Inst.Pkg., Grad.I.E.D., A.M.I.E.T., Grad.Inst. Mat. Hdg. (34), British, seeks any permanent progressive post of responsibility where devotion to duty, loyalty and hard work are appreciated. Experience: Workshop D.O., design office and negotiations at any level. Spec. purpose, lamp, lino, packaging machines, machine tools, chemical engineering, factory maintenance. Immediate accommodation for family required. —Please reply BOX V296, MACHINERY, Clifton House, Euston Road, N.W.1.

### REPRESENTATIVES

**Machine Tool Representative,** aged 40, 12 years experience in the London and Home Counties area, seeks similar position. Previous posts held, Jig and Tool Draughtsman and Planning Engineer. Good organiser, who wishes eventually to accept responsibility as Sales Manager.—BOX V293, MACHINERY, Clifton House, Euston Road, N.W.1.

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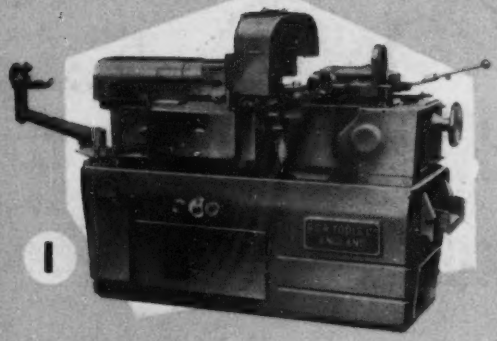

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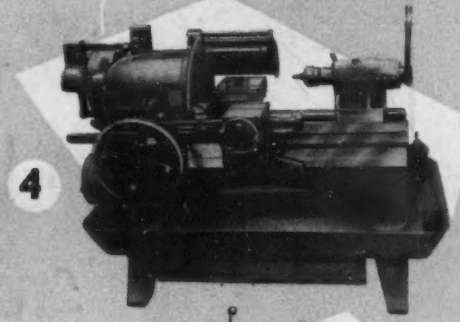

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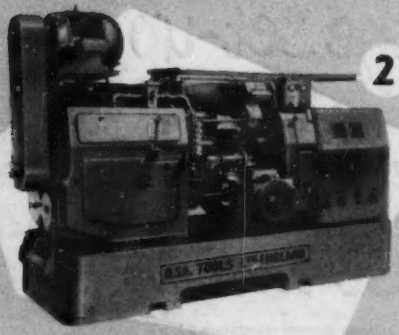

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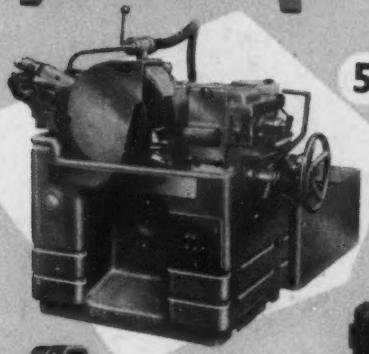

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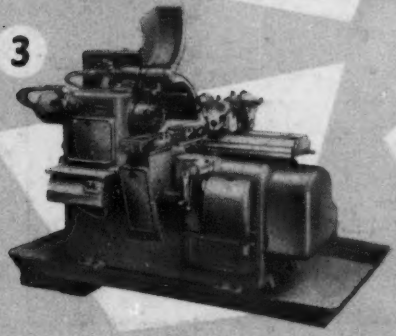

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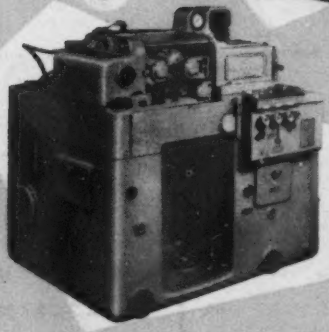

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